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**Health Management Information System Consultancy
to the Basic Health Services Cell
Ministry of Health, Islamabad, Pakistan**

Trip Report

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Management Sciences for Health, Boston
March 21 - April 12, 1994
funded by UNICEF

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Acknowledgements:

I would like to thank the entire HMIS team of the Pakistan Child Survival Project (PCSP) for their excellent support and encouragement during this very busy visit. In addition, I am grateful to Dr. Naveed at UNICEF for making this, my eighth and final visit, possible when other funding ran dry. On the Government side, I'm grateful for the warm reception I've continued to enjoy from Drs. Riaz Malik and Mustaq Chaudhry. It was very satisfying to be able to assist in completing the final stages of this strategic management information system.

Purpose of the Consultancy:

This consultancy was organized to finalize the development of software for Pakistan's Health Management Information System for First Level Care Facilities (HMIS/FLCF). Specific items in my scope of work were as follows:

- To contribute to the further development of the Monthly and Yearly reports data processing modules as follows:
 - . further developing the feedback reporting system and fine-tuning the "Data sets" procedure
 - . developing "end-of-the-year-processing" procedures in order to archive data sets for future use and year-wise comparisons of certain indicators
 - . conducting in depth testing and critical review of the HMIS software system
- To review and finalize system documentation for the HMIS software, focusing on producing a Technical Reference Manual to facilitate the transfer of software maintenance to Ministry of Health staff when the Pakistan Child Survival Project Extension comes to an end.
- To brainstorm on the development of a training program for a workshop on use of information for health officers to be held early next year.

General remarks:

In spite of having to cut the length of this visit down from the proposed four weeks to just under three, I was able to accomplish a considerable amount. The one item which was dropped from my scope of work was the brainstorming on the training workshop. This was judged to be the least urgent, since Theo Lippeveld, PCSP Acting Chief of Party, has scheduled the workshop to take place next year.

In addition to the activities envisioned in my scope of work, I was also fortunate to be able to accompany Shafat Sharif, the PCSP's Computer Specialist, on an unscheduled

troubleshooting trip to Lahore which was extended from one day to two because of difficulties getting seats on the return flight. This proved to be a very valuable visit for testing the software in its working environment using all types of computer hardware.

An effective management information system is continuously evolving as it adapts to managers' changing information needs, and is thus never truly 'finished'. Nevertheless, I was impressed with the giant effort that the HMIS team has made to bring this state of the art system to its current level of refinement. It has now been implemented in close to 30 sites and I have increasing confidence that it can be maintained with a minimum amount of external support.

Specific activities:

1. Development of "end-of-the-year processing" procedure to archive data from Monthly reports:

Given the large volume of data entered in the HMIS/FLCF Data Processing system each month and the limited storage capacity of the computer equipment being used in the 29 computer centers spread throughout the country, it was necessary to develop a procedure to remove data which is no longer actively used. As most analyses are done on data from the previous month, quarter, or year, we decided to maintain a maximum of 2 years worth of monthly reports on the system at any given time.

I developed an automated procedure which copies this inactive data onto diskettes or tape, from which it can be restored later for special analyses. Because some analyses of longer term trends are envisioned, a set of special summary data files was also developed to maintain a limited amount of aggregated historical data on the system at all times. These summary files are described in the section about the annual analysis below. A detailed description of this archival procedure is included in the technical reference manual in Annex III.

2. Annual Analysis:

One element of the computerized system which had not yet been developed was the procedure for producing an annual analysis of the data collected by the HMIS/FLCF. This is needed to produce an annual statistical yearbook and to analyze long term trends. One problem, which is a result of the need to archive data as the data files grow, was to maintain sufficient historical data on the system at all times without sacrificing too much storage capacity.

I developed a data analysis process which takes a copy of the original data and moves it into files which are totalled by tehsil, year, month and institute type. This reduces the amount of space the data takes up by nearly 90% and improves the performance of queries and reports dramatically. It does not, however, provide any information down to the individual health facility level. Over time, this will allow analyses of trends for as

long as the system has been running.

With this summary data set in place and the first of the Yearly reports arriving in Islamabad from the Rawalpindi district health office, Shafat Sharif and I were able to focus our attention on producing the first reports which form the basis for the annual analysis.

During brainstorming sessions with Theo Lippeveld and Shafat, we determined that the annual analysis process should take place towards the end of April each year -- at a time when it is likely that most annual reports and monthly reports from the previous year will have been entered and corrected. A detailed timetable for the annual analysis process as well as yearly reports data transmission was drawn up and will be circulated along with the updated users manual along with the updated release of the software.

The reports which will be used for the annual analysis get their data from three sources:

- from the annual summary of monthly reports,
- from the yearly reports, and
- using a combination of data from both sources

The following is an initial list of reports which we came up with during our brainstorming session. Samples of those which I completed are included in the Annexes noted on the right.

Health Problems:	Annex
HP1* Three most frequent health problems (line graph)	1.1
HP2* EPI diseases trend (line graph)	1.2
HP3* Any Priority Disease (table)	1.3
Health Services:	
HS1* New cases trend for curative care (bar graph)	1.4
HS2 Prenatal and Maternity services trend (bar graphs)	
HS3 Family planning new acceptors by method (stacked bar graph)	
HS4 Growth monitoring new registrations by nutrition status (stacked bar graph)	
Health Resources:	
HR1 Proportion of FLCFs with piped water supply (table & map)	
HR2* Proportion of FLCFs with functioning electric supply (table & map)	1.5
HR3 Health Facility inventory lists of standard equipment for :	
. Child care	
. Mother care	
. Clinical diagnostic	

The asterisks next to the report numbers indicate those which I was able to prepare during my visit. Because of time limitations, I focused my efforts on developing procedures to produce at least one from each combination of data sets. Further reports

using the same data sets will be relatively easy to produce based upon the initial formats produced.

3. Testing and Critical Review of HMIS/FLCF Software:

Once again, the unforeseen volume of new development work limited the amount of time that I could spend on the testing and review work. Shafat Sharif had, however, made an excellent start on putting together a testing outline -- which I pulled together into the format attached in Annex II. Plans were made for a testing team consisting of Shafat, Gohar and Aamir Butt, from the Provincial Health Directorate in Lahore, to go through each of the testing steps over the next several weeks. Shafat can then incorporate the feedback into the next release of the software.

The unexpected troubleshooting trip that I made to Lahore proved to be an excellent opportunity to test the system's implementation on a wide variety of computer hardware configurations. In addition to running the system on the Punjab Provincial Directorate's AST desktop computer and the Lahore Division's Toshiba notebook, data entry staff from both Sheikhpura and Multan came in with their Toshiba and AST notebook computers with a variety of problems to troubleshoot.

Although several of the system's modules have been operational for more than a year, the implementation of the entire system in 29 sites distributed throughout Pakistan has proved to be an enormous challenge. The most critical problems that we encountered during this visit were due to factors which are difficult for us to control with our software: problems related to virus infestation, cross-linked files, damaged sectors on hard disks, computer battery problems, and incorrect configuration of computers. Nevertheless, we also identified a couple of fairly serious bugs and some enhancements requested by the users which we were able to correct and incorporate in the next release of the software.

The Sheikhpura District's Toshiba 2000EX computer appeared to be in the worst shape. It got a serious computer virus -- Possessed 3 -- which was not detected by the early release of Central Point Anti-Virus program that is configured to run each time the computer boots. This resulted in damage to the FoxPro overlay and library files, without which the software will not run. It may have contributed as well to a curious symptom where nearly every record in the monthly reporting files had a blank duplicate. Fortunately, this appears to have taken place during the back-up process, as their main database files were relatively clean. In addition, the computer had a number of cross linked files: a fairly common symptom of turning off the computer before exiting the database software.

Multan's AST 386/SX 20 notebook computer had a completely different set of problems. Somehow, computer operators there had managed to modify the computer's autoexec.bat and config.sys files. As a result, the anti-virus software and the expanded memory manager were not running, nor was the computer loading the Direct Access

menu software. Although the computer operator was able to run the software it was running terribly slowly. In addition, the computer's rechargeable battery was completely flat and unable to hold a charge and the hard disks had a good number of cross linked files. Most of these problems were quite easily corrected by re-running the installation procedure, but this experience does highlight the need to train computer users to avoid modifying any of the configuration files.

The Lahore division's Toshiba 2000EX computer was in pretty good shape, although it still had version 1 of the software loaded on it. This has not been a problem, since they have yet to enter any Monthly Reports data from their districts. We loaded the new version of the software and used the opportunity to test the graphics software -- EPI MAP and FoxGraph with the external monochrome monitors that were supplied by UNICEF. These worked fine with EPIMAP, but we were unable to get them to display the FoxGraph output. Unfortunately, the Toshiba laptops were provided without the correct documentation and without the diagnostics and utilities disks that are needed to change video modes. The good news is that both graphics packages worked fine with the laptop's internal LCD monitor.

Details about the complete range of problems what we uncovered are included in the notes that we recorded in Annex III. The principal software specific problems which we uncovered and have been able to address in version 2.1 of the Monthly reports system were as follows:

- ◆ An error in the Change Id function which is intended to allow users to modify the key fields of a Monthly or Yearly report if the institution, month or year are entered incorrectly. This was not actually changing the rpt_id number in all of the linked files (MONTHRPT, STKFLAT and VACFLAT). As a result, some of the related files were being "lost". New logic was built into the system to make sure that all of the appropriate fields are updated.
- ◆ A problem with the design of the batch transmission system. This was changed recently to delete all records from the institution file for the reporting district before appending the updated ones from the new batch. If, by mistake, a district entered even 1 record from another district, all of the second district's data was deleted. This problems became apparent after we received the data from Saidu Sharif. Shafat re-wrote the procedure to update records in the institution file individually as had been done in version 1.
- ◆ A problem with duplicate, mostly empty records being created in the Monthly reports module. This problem seems to have gone away once version 2 was sent to the computer centers around August or September. Nevertheless, this still needs to be tested carefully, as duplicate data will cause serious problems with data analysis and reporting later on.
- ◆ The excellent generic programs that Shafat has written to produce maps and graphs by linking EPIMAP and FoxGraph to FoxPro caused problems when the software was transferred to different sub-directories. I made changes to these programs to use relative references to files in related sub-directories, rather than

- hard-coded complete paths.
 - ◆ The data set procedure generated an error message when trying to print out the data dictionary and when trying to create files other than in the .dbf file format. These procedures were modified and appear to be working correctly now.
 - ◆ The saverec() function that is used to save data as the user moves from screen to screen used a LOCATE command to find the record to update. This is much slower than a SEEK. We made this change and expect to see improved performance during data entry and editing.
 - ◆ One field each in a couple of records entered in the MONTHRPT and VACFLAT files had invalid data caused by data overflowing the width of the cells (TB_RX_THIS and OPV_0). This was apparently the result of a difference in the width of these fields on the screen and in the data file in an earlier release of the software. I developed a procedure CHKARRY to find these errors and allow them to be easily corrected (Note: this only runs using the standard version of FoxPro, not the extended version). It would be useful to include a procedure like this in the next release of the software. Anything that will help to maintain the integrity of the data through the complicated data transfer mechanism that is in place will be helpful and will result in better data quality later on.
4. Preparation of the Technical Reference Manual:

My last 3 days were spent working principally on the Draft Technical Reference Manual which is included in Annex IV. This reference document will be a critical resource for new systems analysts and programmers who become involved in maintaining and enhancing this software in the future. I focused my efforts on documenting the procedures and utilities that I developed more or less independently. Shafat will complete this effort by preparing the remaining sections where he was the principal developer.

This document contains a detailed overview of the system design, database structure, programming tips, a detailed data dictionary, and documentation for all screens, report forms and menus. The last 4 sections are voluminous and are therefore not included with my trip report. They will be incorporated into special ring binders for easy reference and updating.

Shafat and I also spent some time discussing with Dr. Riaz Malik the need for better programmer support within the Bio-Statistics Cell which is likely to inherit the maintenance and development of this software in the future. He has drafted a letter to the Director General on this issue and we all hope that action is forthcoming -- perhaps before the HMIS team of the Pakistan Child Survival Project is disbanded in June.

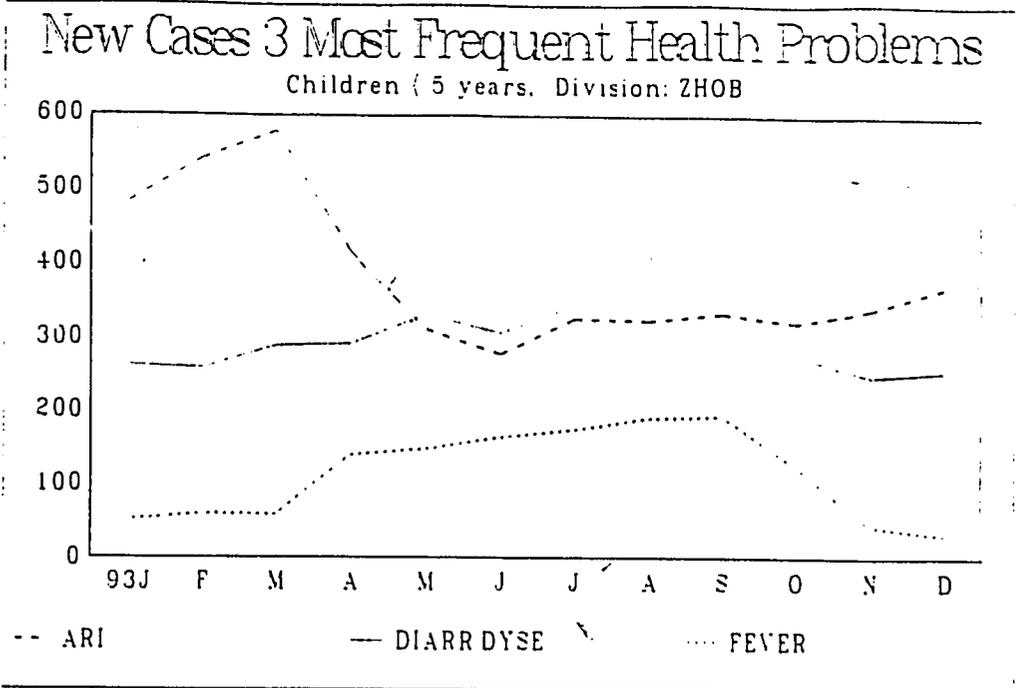
Conclusions and Recommendations:

1. Most of the findings of the initial informal testing have now been incorporated into

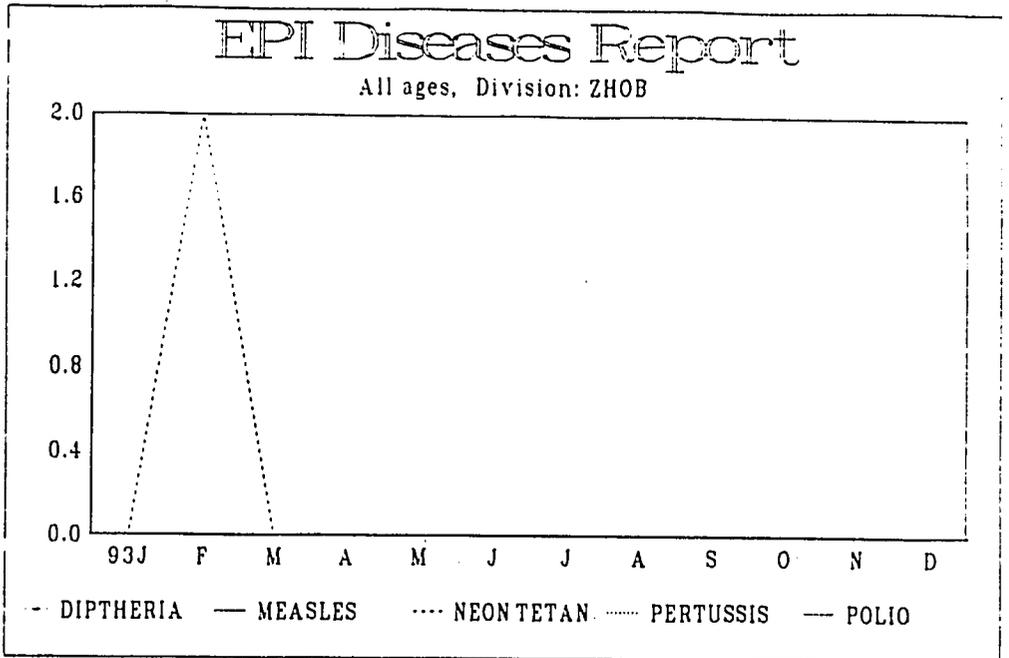
the software. More formal testing with the help of Aamir Butt, from the Lahore office, should take place over the next 2 weeks in order for changes to be made to the system before the release of the next version of the software. This is expected to be around May 11th, when the last National HMIS Workshop is held.

2. Shafat has done an excellent job integrating the User's Manuals from the HID, Monthly & Yearly Reports modules. Notes for the Training Database should also be incorporated into the final product. Because of the tendency for user's manuals to get misplaced, most of the text from this document should also be in the on-line help database.
3. More needs to be done to increase the computer operators' awareness about the dangers of computer viruses and the importance of good database maintenance. The next release of the software should include the latest version of McAfee Anti-virus and the Users Manual should have a section on virus prevention, computer configuration, and running CHKDSK to clean up cross linked files on hard drives.
4. Additional reports for the Annual Analysis should be produced before the May 11th meeting, so that medical officers from the provinces can provide feedback on their usefulness and contribute to the design of this process.
5. Considerable effort should be made on the part of the Basic Health Services Cell (BHSC) staff, the HMIS team, UNICEF and other donors, to strengthen the capacity of both the Bio-Statistics Cell (BSC) and the Basic Health Services Cell to manage the continuing implementation and evolution of the HMIS/FLCF once the project comes to an end. This should include:
 - a. securing a commitment to recruit a technically qualified programmer and a doctor with epidemiology training,
 - b. providing computer equipment upgrades for the implementation of the system at the federal level,
 - c. continuing training in data collection and use of information,
 - d. establishing an effective mechanism for funding the recurrent costs of printing forms, registers and feedback reports,
 - e. and agreeing formal lines of communication for data from the Provinces to Federal departments and programs through the BHSC and BSC.

ANNEX 1.1



ANNEX 1.2



District	New Cases		
	< 1 year	1 - 4 years	5 years +

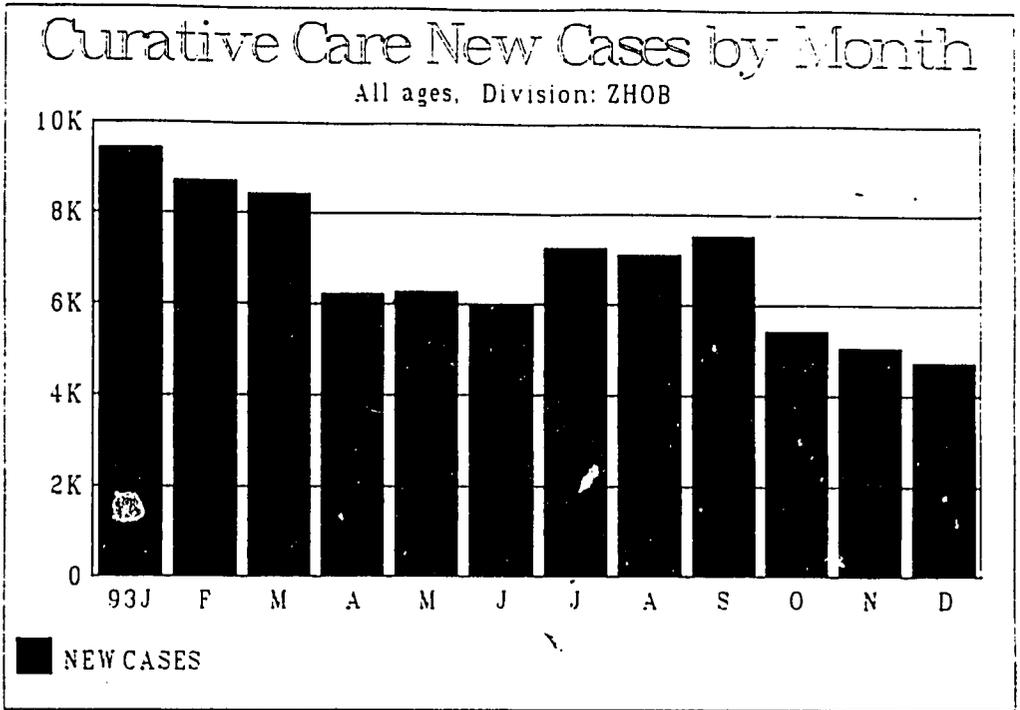
Division: SIBI

KOHLU	97	224	644
SIBI	138	364	867
	235	568	1511

Division: ZHOB

ZHOB	336	845	2294
	571	1413	3805

BEST AVAILABLE DOCUMENT



BEST AVAILABLE DOCUMENT

YR_CUR

Province: PUNJAB

District	RHC		BHU		MCH		OTHER	
	No.	No.	No.	No.	No.	No.	No.	No.
	Tot. W.Elec %		Tot. W.Elec %		Tot. W.Elec %		Tot. W.Elec %	

Division: RAWALPINDI

ATTOCK	0	0	0%	5	3	60%	0	0	0%	0	0	0%
RAWALPINDI	5	3	60%	51	27	52%	7	6	85%	0	0	85%
Total for Division:	5	3	60%	56	30	53%	7	6	85%	0	0	0%

BEST AVAILABLE DOCUMENT

Testing notes for Monthly reports system:

Tester:

Site:

Date:

Procedure to test	Pass/Fail	Comment
<p>1. Adding records:</p> <ul style="list-style-type: none"> a. non-existent INST_ID b. known existing monthly report. c. record with vaccinations d. record without vaccination 		
<p>2. Editing records:</p> <ul style="list-style-type: none"> a. Find record to edit <ul style="list-style-type: none"> Using Find button Using Search button b. Moving around screens: <ul style="list-style-type: none"> • <Alt> + Number • <PgDn> i. Error checking: <ul style="list-style-type: none"> • Run procedure • Correct fault • Run again • Check report • Check error flags 		
<p>3. Deleting records:</p> <ul style="list-style-type: none"> • Delete records (Use record with and w/o Vaccinations) • Quit system and check to see that records are marked for deletion in Monthrpt, Vacflat & Stkflat • Undelete records. • Quit system and check to see that records are recalled in Monthrpt, Vacflat & Stkflat. 		
<p>4. Changing id code:</p> <ul style="list-style-type: none"> • Change to new year, change month, change inst_id. • Try to change to known existing Rpt_id. • Change record with and without vaccination records. 		
<p>5. Reporting:</p> <ul style="list-style-type: none"> a. Test each report format option to screen, printer, file. b. Test each graph c. Test each map. d. Test file option: <ul style="list-style-type: none"> Enter invalid filenames (eg. &- 899\ and testfile1.txt) Enter existing filename (eg. temp.dbf) Enter invalid path (e.g. c:/dkdk) 		

Procedure to test	Pass/Fail	Comment
<p>6. Printer setup: Create a new printer driver to make sure this option works and you have no out of memory problems.</p>		
<p>7. Batch transmissions: Change some records. Prepare batch to drive A: Change some records in monthly reports (take note of rpt_ids). Prepare another batch to drive B: (if PC has one). Check to see that Batch report lists correct number of records. Exit system and unzip contents of Batch files. See that batch numbers are in Monthrpt file See that correct rpt_ids have been batched. Try to reload the same batch on the PC (should not allow) Take batch to another PC and Upload batch. Create a new batch on the 2nd PC to see that latest data is also transferred. See that batch numbers are in Monthrpt file See that correct rpt_ids have been batched.</p>		
<p>8. Create data sets: Run each procedure Try different date ranges including those not on file Try to different file formats.</p>		
<p>9. Archive data process: Change some ID numbers to 1992. Run the archive data process Makes sure all records were totalled correctly in the summary database. Check that the format of the new RPT_ID is correct. Make sure archive files contain all archived records from Vacflat, Stkflat and Monthrpt Make sure all records in the original files were deleted</p>		

Annex III

HMIS/FLCF Database Testing Findings

Site: Lahore Provincial Health Directorate
 Hardware: AST Premium/386 dx 25 Desktop, VGA Monochrome AST Monitor, 200mb hard disk
 HP DeskJet 500 printer, Epson LQ1170, Epson LQ1050 +
 240mb, IRWIN Accutrack Tape drive.

Comment	Type	Action
1. Problem with paper size during printing on A4 sheets with HP Deskjet 500.	Hardware	Set dip switches A6 & A8 up
2. Problem with unpredictable printing with Epson LQ1050 + W00702 Bios.	Hardware	Unable to resolve this, fortunately all Epson printers provided by project have later BIOS, so problem doesn't occur.
3. Sheikhpura Toshiba 2000XE: Infected by Possessed 3 virus, Monthly, Inst and other executable and overlay files would not run. Many cross linked clusters in file allocation table	Virus	Cleaned viruses with Mcafee. Reinstalled fresh executable files and program ran fine. Need to insist on stricter anti-virus measures. Also used chkdsk /f to fix & remove cross linked clusters in the file allocation table.
4. Multan AST PowerExec 386/20: Program runs very slowly or not at all. Several errors when running autoexec.bat file and menu program would not run. Many cross-linked clusters in file allocation table.	Config.	Someone modified the config.sys and autoexec.bat files. DOS was no longer loaded high, no expanded memory and path no longer included HID or menu program. Reinstalled HID and Monthly reports, all problems disappeared. Cleaned up hard disk using chkdsk /f to fix lost clusters on drive.
AST battery no longer holds charge.	Hardware	Needs new battery. Users need to be trained to recycle notebook computer batteries by discharging them completely and then recharging them fully several times.
5. HID module: Graphic reports: Menu option is not disabled if foxgraph is not installed.	Error	Replaced skip for in foxgraph menu options with: not file(.\graph\foxgraph.exe).
Problems finding foxgraph.exe and foxgraph.dat files.	Error	Replaced hard coded paths in GENGRAPH with ..\Graph, ..\GIS. Changed Gengraph.prg to store foxgraph.dat file in 3dlooks\foxgraph.dat.

Comment	Type	Action
Soelling error in Institution Type Graph. "Institutions"	Error	Changed Title parameter to "Health Institutions Database"
6. Monthly reports module: a. Data set procedure: Data set report listing procedure did not work. Missing Batch.dbf and column " " not found error messages.	Error	Last update of s/w did not include Monthx.dbf and .cdx. These need to be updated to include all new field names in the files and distributed with the install disk.
b. Batch Transmission: Problem with substring function to create batch number "Post.dbf not found" error message when running batch procedure	Error Error	Changed substring function to overcome problem in BATCH.PRG. Changed file name in BATCH.PRG to "B_posts" from "B_Post"
c. Graphic reports. Problem with hard coded paths to load foxgraph and EPIMAP.	Error	Replaced hard coded paths with ..\Graph, ..\GIS. Replaced skip for in foxgraph menu options with: not file(..\graph\foxgraph.exe). Replaced skip for in EPIMAP options with: not file(..\gis\epimap.exe). Created new public variable home_dir = sys(2003) to allow easy switching back to an application's home directory: set default to (home_dir).
Unable to find FoxGraph data file	Error	Changed GENGRAPH.prg to store foxgraph.dat file in 3dlooks\foxgraph.dat.
Legend labels on graphs are too cryptic.	New feature	Developed procedure to rename labels in procedures calling GENGRAPH.prg. Added Title, Subtitle, Column and Gr_file parameters.
d. Text reports: Report selector prints blank page if there is no data for report. It should just affix a message and ask if user wants to use different selection criteria or cancel the report.	New feature	

Comment	Type	Action
Log Report: Problem with calculation of reports received (Class I) monthly variables, reporting regularity and Error rate formulae	Error	Corrected
DS-3 District Mother Care report too wide for DJ500. Should narrow label in central column.	Error	Edit DS-3 report form. Need to narrow by about 2 characters.
Location popups on report selector are enabled at every level. Division and district popups should be disabled at district level as there should be only one district on file. Division should be disabled at division level, as there should only be data from one division.	Error	
Report selector should display menu prompt for report being run.	New feature	Added Report: prompt() at bottom of report selector screen.
User should have option to send reports to a text file for easy input into a WordPerfect document.	New feature	Modified REP_SEL to include <<File>> button
Print destination should be disabled for GIS and FOXGRAPH reports	Error	Modified REP_SEL screen to disable print and file destinations when "graph" or "map" are in the report's menu prompt().

Site: Lahore Divisional Health Office
 Hardware: Toshiba 2000XE and Epson

Comment	Type	Action
1. Problem with paper size during printing on 11" continuous paper with LQ1050 + W12203 BIOS.	Hardware	Set dip switches SW2-1 and 2-2 off for 11" paper. Adjusted paper alignment down to start even with top of plastic paper guide on print head. Excellent quality output obtained.
2. Problem with switching from external monitor to screen when power goes off. Cannot see status, etc..	Hardware	Need to obtain Toshiba system disks and user manual to run ROM setup utility. Set Resume feature on. If there is a power outage, users should press Esc and turn off their PCs until the power comes back on. With Resume feature on, computer will restart precisely where it was left without damage to data.
2. HID: Old version, no data had been batched in from District Offices.	Software	Installed new version. Demonstrated use of FoxGraph.
3. Hard disk almost full, unable to complete batch upload process of Sheikhupura data.	Config	Cleaned up hard disk. Removed all \$*.* files from HG directory. Deleted tmp files. Reran batch restore procedure.
4. Monthly Reports: Old version, no real data entry has been done yet by the Divisional office.	Software	Installed new version and tested FOXGRAPH and EPIMAP options.
a. EPIMAP- will run on either the laptop or the external Samtron Monitor. EPIMAP graphic report options do not work from Monthly Menu.	Error	a. Need to create map files for Punjab and other regions and set up mechanism to automatically select these maps when run in a given region.
b. EPIMAP will not print -- need to install printer driver files with EPIMAP.	Config.	b. Ship \$*.BGI and \$*.INI files with GIS program files.
c. Batch Restore program gives error message "file B_post does not exist."	Error	c. Bug in BATCHIN.PRG. Variable b_post re-initialized to "b_posts". Fixed.
d. Batch.DBF does not store correct computer center ID number.	Error	d. Bug in Batch.dbf. Line in memo field from which data ID code is parsed varies in length. Developed different method of extracting code using right(trim(memoline())).

Comment	Type	Action
e. FOXGRAPH does not display on external Samtron monitor.	Hardware	e. Need to install FOXGRAPH with EGA driver or use Toshiba with internal LCD monitor.

Site: Islamabad PCSP Office
 Hardware: Everex 386 dx computer with 300 meg hard drive, Laserjet III Printer

Description	Type	Action
<p>1. Archival Module for Monthly and Yearly reports data: This procedure, to be run at the beginning of each year, should copy to floppy disks or tape all data which is more than 2 years old. The procedure should begin by creating annual summary tables of monthly reports data for the archived data. These should be totalled by tehsil, by month. An effort should be made to remove unnecessary fields to cut down on space requirements. Once archival process is complete the archived records are deleted from the master files.</p>	New feature	<p>Wrote procedures ARCHIVE.PRG and MAKESUM.PRG to summarize 2 year old records to MONTHSUM, STKSUM and VACSUM files (by Tehsil and Report Month). The archive process then copies the old records to new files: MNTARC99, STKARC99, VACARC99 which are copied to floppy disks. Finally, the old records are deleted from the original database files and the files are packed.</p>
<p>2. Annual Statistical Analysis: This exercise should be conducted in April or May of each year, giving facilities a chance to enter and correct as many reports from the previous year as possible. The procedure should have several steps:</p> <ol style="list-style-type: none"> Analyze Institutions Data: Analyze Monthly report data: Analyze Yearly report data: Prepare summary tables and graphs to be include with text for Annual Statistical Report Prepare specific feedback reports for Provinces, Divisions and Districts. 	New feature	<p>Wrote a generic procedure MAKESUM.PRG, also used by the archive procedure, to summarize records from any year to the MONTHSUM, STKSUM and VACSUM files (by Tehsil and Report Month). This has been added to the menu as "Update summary data" and should be run before conducting the annual analysis. These files then became the basis of much of the annual analysis reporting procedure.</p> <p>Developed new report criteria selector screen REP_YR to be used in selecting records and levels of data aggregation (eg. Province, Division, District and Monthly, Quarterly) for annual analysis reports.</p> <p>Designed Graphic reports for 3 Top Health Problems, EPI Diseases, and Curative care trends.</p> <p>Developed Health Resources text report using data from the Yearly Reports to show % of health institutions by functioning electricity supply.</p>

Description	Type	Action
3. Make reindex procedures more robust in case an index tag is accidentally deleted.	New feature	Use "INDEX ON .. TAG .." to recreate each index tag rather than a simple REINDEX command.
4. Data set procedure: Data dictionary procedure does not work if option other than .dbf is chosen. Display of Message should say press any key to continue. Send report procedure does not work correctly.	Error	Fixed data set procedure to delete temp .dbf file after data dictionary is printed. Modified prompts. (Menu options EPI Data, Malaria Data, TB data, in MONTHLY.MNX); Changed EX1.prg makedic procedure created variable m.act to send data to printer or screen.
5. Change ID procedure: Does not function correctly, it does not change ID numbers in related files (VACFLAT and STKFLAT). Displays a message if changing to a report id number which already exists, but changes it anyway.	Error	Changed validation procedure in RPT_YEAR field to perform needed actions in both MONTH1 and YEAR1 screens.
6. Moving around records: Next key displays a blank record when pressed when displaying the last record in the file. If you don't press <Quit> this could cause blank data to be gathered back to the last record.	Error	
7. Monthly screen set: Locate is used instead of seek in each activate clause and in the saverec function in EX1.prg. Seek would be faster.	Enhancemt.	Changed locate for to seek m.rpt_id in each screen and in the saverec function.
8. D_LOG report: Should consolidate report to include information on Yearly reports received as well as monthly. Quetta office reported log report not showing "No. of expected reports (Class I)" in the summary at the end of the page for Zhob district.	Enhancemt. Error	Added extra column for yearly reports. Most likely due to fact that the log report was run before the restore or upload batch procedures were completed, this initialized the reporting rate variables. When the process was completed, and the report was run again, these variables were not re-initialized. Modified MONTHLY menu to re-initialize the reporting variables each time the user completed data entry, upload or restore procedures.

Description	Type	Action
9. D_CURA report: the denominator for percentages for ARI and Diarrhoea was based on total new cases > 5, making the % too small. to		Changed the denominators to new cases ARI and new cases Diarrhoea, respectively.
10. Duplicate records being created in Monthly reporting data entry procedure. These appear to have been primarily from records entered before Aug. 1993. There are only a few duplicates for later months. The same problem appears to happen with MONTHRPT, STKFLAT and VACFLAT records.	Error	This is a serious problem, as it will require considerable manual cleaning of the data. I think most of the problem can be attributed to an early version of the monthly reports module, since the problem has mostly gone away since version 2 of the software was distributed in September 93.
11. Receive error message "Field overflow, data was lost" during Archive and Update Summary data procedures.	Error	This was due to 2 records in the Sheikhpura data which were truncated when the data file structure was changed. I wrote a procedure to be used with Foxpro interactively to test for this error occurring in all numeric fields in any database file. Called CHKARRY.prg, this is run by typing: DO CHKARRY with "file_name", where filename is the dbf file to be tested. If it finds an error. This is unlikely to occur in the future now that the widths of the memory variables on the screen and those in the database have been harmonized.
12. Report from Malakand division office: Batch upload procedure of data from Swat district deleted all records for Malakand district and user had to reenter these.	Error	After inspecting swat's HID data, it was found that one record was mistakenly entered from Malakand district in the Swat district office. That caused the deletion of all district records as the first step of the uploading or restoring procedure is to delete all HID records for the districts on the diskette, before uploading them from the diskette. This process was developed to tackle the problem where institutions which are deleted at the peripheral level remain permanently on the system at higher level. Changed the upload procedure in the Reporting Module and the restore procedure in the HID to delete matching INST_IDS prior to appending, instead of deleting the entire district. Added a message in the institution delete menu suggesting not to delete and to use the same record for a new institution later on instead.

ANNEX IV

HMIS Data Processing System

Institutions (HID), Reporting, Personnel, and Training Modules

Technical Reference

DRAFT

Developed by:

The Health Information Systems Team, Pakistan Child Survival Project, Basic Health Services Cell,
Ministry of Health, Government of Pakistan

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Technical Reference for the HMIS/FLCF Data Processing System

DRAFT April 14, 1994

This document is intended for systems analysts and programmers who will be involved in maintaining and extending the features of Pakistan's Computerized Health Management Information System for First Level Care Facilities.

It provides detailed information about the design of the system and the structure of both databases and program code. Information about using the software is covered in a separate Users Manual.

1. **System overview:**

a. **Purpose:**

The computerized HMIS/FLCF has been developed as the data entry, batch transmission, and feedback reporting system for the nationally implemented Health Management Information System. Its modular design features 3 principal modules: a Health Institutions Database (HID), a Reporting module, and a Training database. In addition, a Personnel module has been designed, but this has yet to be implemented. See figure 1 for a schematic representation of the key modules in the system.

b. **Development Methodology:**

This system was developed principally with FoxPro 2.0 relational database software. This software was chosen in 1991 for the following reasons:

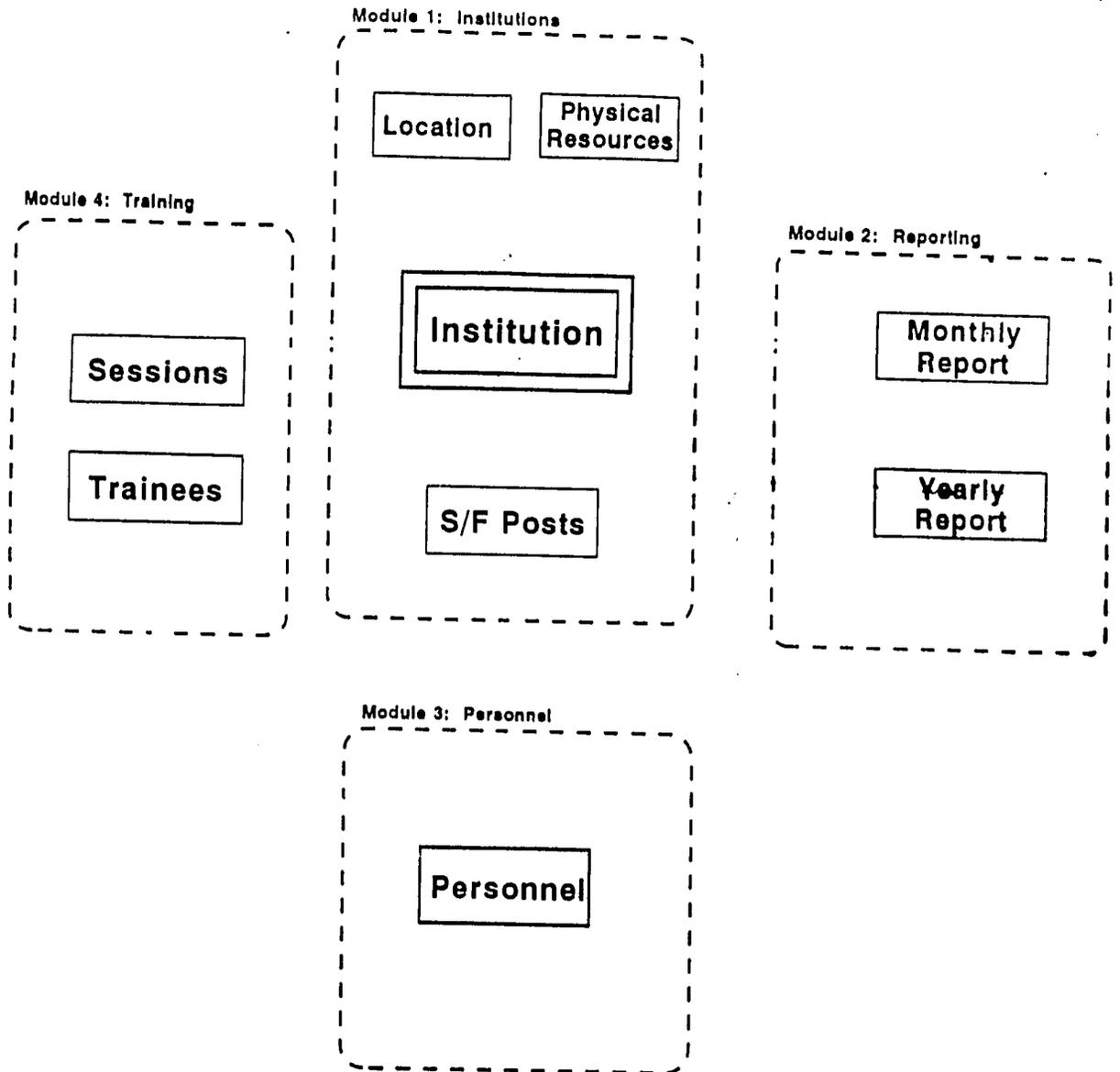
- i. compatibility with code and xBase file structure of the Primary Health Care Monitoring System, which was a system developed for the Ministry of Health in the late 1980s
- ii. excellent performance and support for SQL query language
- iii. powerful interface development tools for designing screens, reports and menus.
- iv. character based windows-like interface which should ease the transition of users to the windows interface should the software be upgraded to this platform

The modular design of the system was chosen to permit the system to be implemented in a phased manner, beginning with the Health Institutions Database in 1992 and adding shortly thereafter the Training and Monthly Reports Database.

This phased implementation was done for several reasons:

- To enable administrative units within the Provinces the time to gather and enter data on all of the health institutions under their direction before routine reports began flooding in which need to be associated with these institution records.
- To simplify the training of computer operators, who could be quickly trained in a single module, but to whom the complete system might have seemed overwhelming.

Structure of Pakistan's HMIS Data processing System



- To seek end-user input to the software development process by testing the overall user interface with one module in an operational setting prior to completing the design and development of other modules. This process of "prototyping" provided the developers with excellent feedback which they were able to incorporate into the development of later modules. In addition, it helped to build a feeling of ownership on the part of end-users.

It was decided very early to develop the software relying as much as possible on FoxPro's power tools and code generator. This means that most of the software's program code is maintained by project files and contained in menu, screen and report forms. Only a limited number of generic hand-coded procedures are incorporated into the system's master program file: EX1.prg. Although mastering the FoxPro power tools was initially a challenge for the programmers, relying upon them has simplified the maintenance and expansion of the system. This should make it reasonably straightforward to support once the project ends.

In addition to FoxPro, two other software packages have been used to produce graphic reports at some levels: FoxGraph for line and bar graphs and EPIMAP for the Geographic Information System charts. These are both executed through the FoxPro menu structure using the RUN or FOXSWAP features, so that the integration of these reports is more or less seamless to the users. Both of these applications have associated data files which are also required for the system to function correctly.

- c. **Implementator. of the system.** << to be done by Shafat Sharif >>

2. **Overall System Structure:**

a. **Database Design:**

Just as the user interface has evolved through the prototyping process, so has the database structure. What began as a heavily normalized relational database design has been partially de-normalized to cut down on the absolute number of records in each file and to simplify report generation. The principal de-normalization was done on the Monthly and Yearly report files which contain repeating data on stock (amount rcd, amount used, days out of stock) and on vaccinations (number of children immunized by age group and by antigen). In addition, the number of fields in the Monthly report records were such that they had to be split into 3 separate files with a 1 to 1 relationship (MONTHRPT, STKFLAT, VACFLAT).

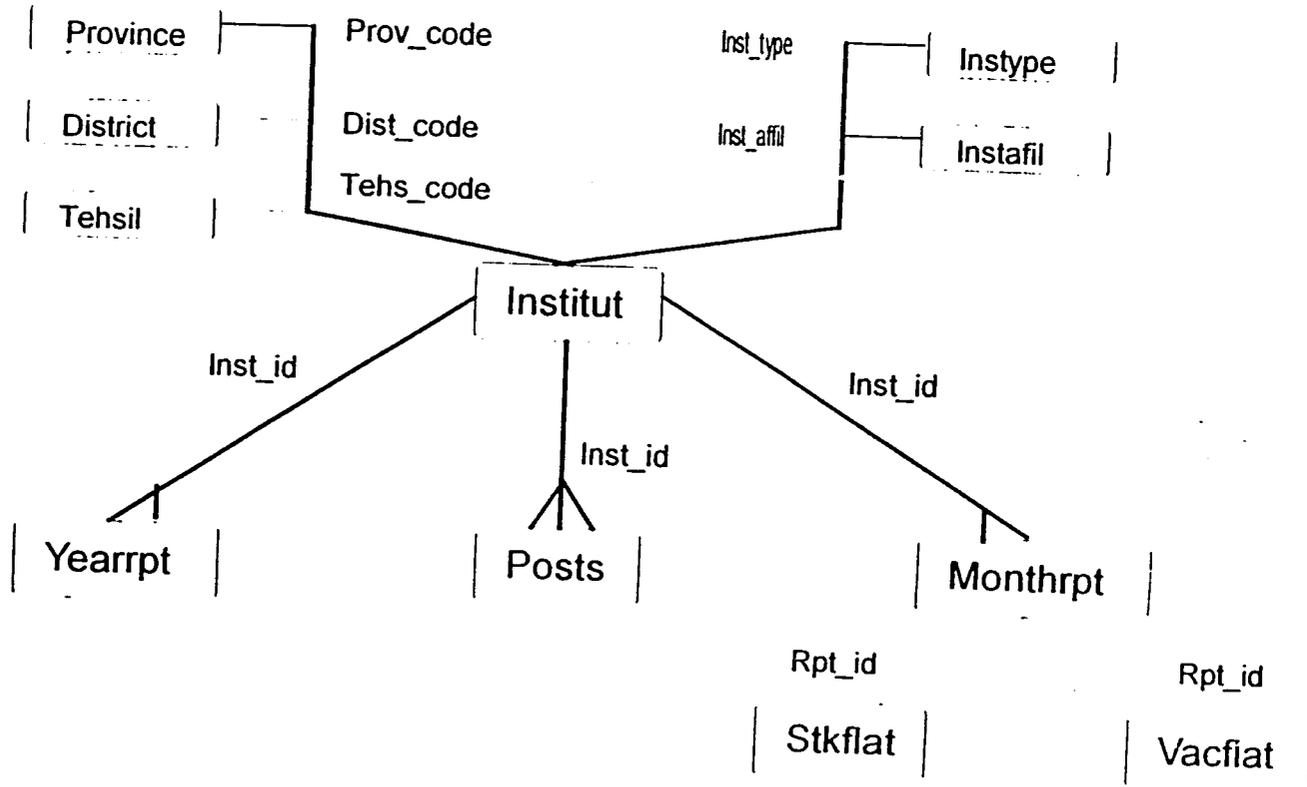
The figure on the following page illustrates the system's current file structure.

Critical to the implementation of each module was the maintenance of the Health Institutions database and the Geographic location tables. This is done through the HID module which is maintained in the directory HID. In addition to the INSTITUT file, this contains, the following lookup tables, which are used to validate data entered and store related information, such as population for province, district and tehsil:

INSTYPE	Institution Type
INSTAFIL	Institution Affiliation -- Class
PROVINCE	Province data
DIVISION	Division data

Data Diagram

HMIS/FLCF Data Processing System



DISTRICT	Division data
TEHSIL	Tehsil and Taluka data

Due to the amount of data being collected, an aggressive archival strategy has been adopted for the Monthly reporting system. Monthly reports data is maintained on the system for a maximum of 2 years, after which time old data is moved to disks or tape. In order to permit some long-term trend analysis, three summary data files are maintained on the system once the old data is moved. These store key data aggregated by tehsil, institute type (BHU, RCH, MCH & OTHER), year and month. They are about 10% the size of the original records, so most systems should be able to store these summary records for the life of the system. These files are updated automatically during the archival process which calls the procedure MAKESUM.prg. Yearly reports and HID records will never be archived.

The Training Module has an optional link to the Health Institutions Database through the inclusion of an INST_ID field in the TRAINEE records, although that module may be used independent of the HID.

b. Project Design and Program flow:

All of the elements components of these modules are contained in 3 FoxPro project files which are stored in the main directory of each module. These contain all of the screens, menus, programs and report forms which are used. Any changes to any of these components must be done through the project manager and then the application can be rebuilt. Due to the large size of FoxPro's full size executable files, these modules are all compiled and linked as Compact executable files. These will only run if FOXPRO.ESL and FOXPRO.ESO are also distributed with the software and are in the computer's path. With multiple modules, this approach saves a considerable amount of disk space, since they can all share one set of FOXPRO runtime files.

Monthly Reports module:

The menu structure chart on the following page gives an overview of program flow. The system always begins by displaying the startup screen. Then the Main menu is displayed with the initial menu pad (System) activated.

At this stage, the user branches to one of 3 principal functions (Edit and Record menus are only used during data entry).

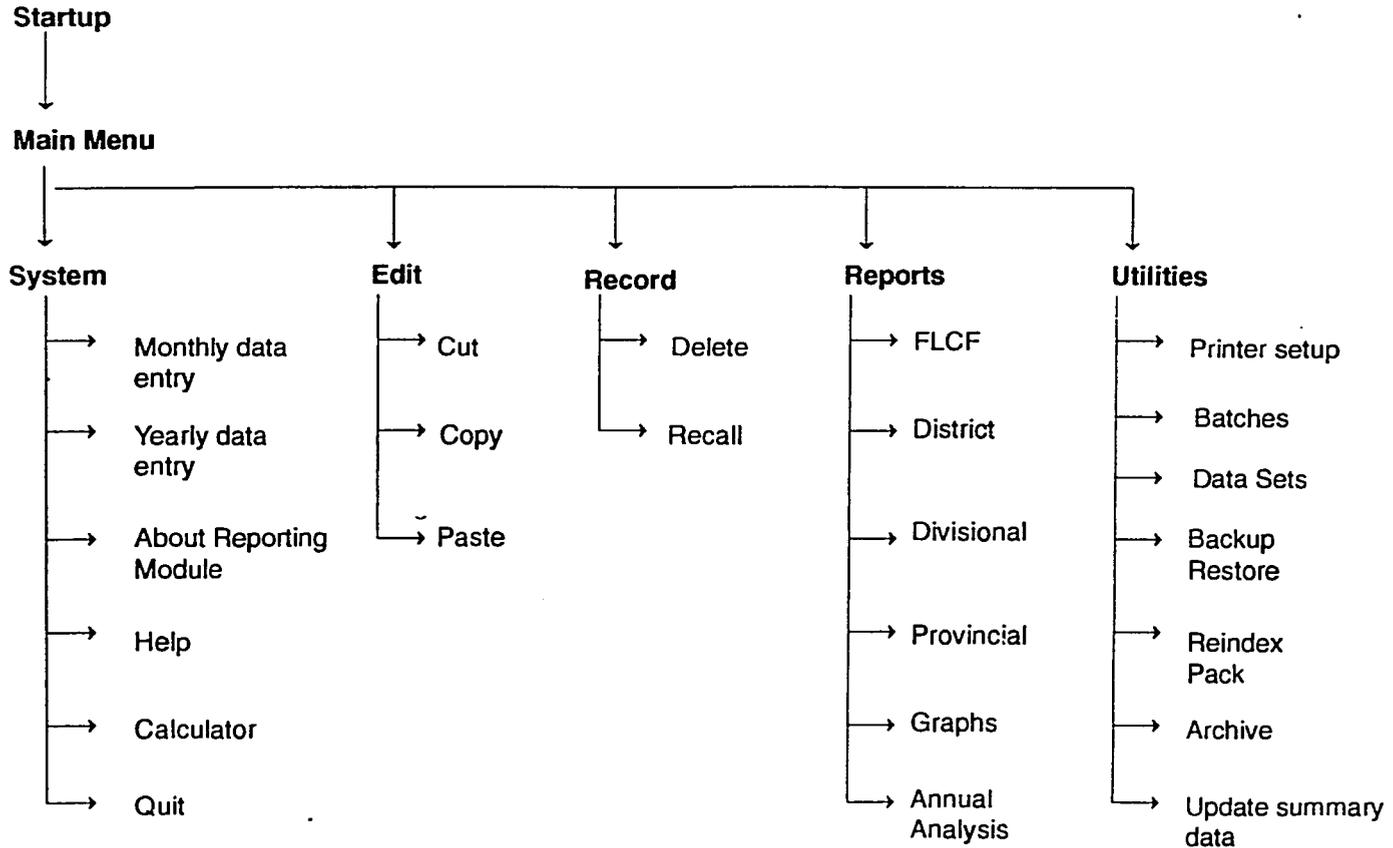
i. Data entry Screen Sets:

There are two separate data entry options in this module. Entry of Monthly Reports and entry of Yearly Reports. These are both accessed from the System menu pad. In each case these options call screen sets in which data is entered. Each screen set is controlled by a Control Panel, which contains push buttons to control movement through the databases and the following often used procedures: Adding records, Error Checking the current record and changing a record's ID code -- in case the incorrect month, year or institution id was entered.

Whenever one of the screen sets is activated, the Reports and Utilities menus are disabled, so that the user does not attempt to run reports or do data maintenance procedures while editing records. Each screen set contains a number of separate screens which are arranged one on top of another and the user can move around between them easily by

Menu Structure

HMIS/FLCF Data Processing System



pressing <PgDn>, <PgUp> or by pressing the <Alt> key and a number (the latter is handled by a series of ON KEY LABEL commands in the EX1.PRG procedures file. In order to exit a data entry screen, the user should press the <Quit> option in the control panel or press <Esc>.

Whenever the cursor moves out of any of the data entry screens, the deactivate clause of each window runs a function called SAVEREC(). This determines which database file should be selected, updates the last_update and batch_no variables, and gathers the data from memory variables back into the appropriate record.

The following sequence of actions are done in each screen:

- (1) Setup: Selects the appropriate database
- (2) Activate:
 - Checks to see if the current screen is on top of all others (this is a trick to force the activate clause to execute a different procedure for each screen -- normally all activate clauses in a screen set are appended together by the FOXPRO screen generator)
 - if so, it selects the database and seeks the record that matches rpt_id.
 - if it doesn't find a matching record
 - a new blank record is appended and the rpt_id field is initialized.
 - then the data from the record are scattered to memory variables and all the gets from the top window are redisplayed.

Below is some sample code from the activate clause of screen MONTH2:

```
IF WONTOP("MONTH2")
  select STKFLAT
  seek m.rpt_id
  if not found()
    append blank
    replace stkflat.rpt_id with m.rpt_id
  endif
  scatter memvar
  show gets window (wontop())
ENDIF
```

(3) SHOW GETS:

Again a trick is necessary here. You can enter any comment into the show window, but it must not be blank or the screen generator will not create a show clause for all of the screen variables.. A typical entry would be: " show gets.

(4) DEACTIVATE:

This clause is run each time a the cursor attempts to leave the current screen. All screens have only two commands in the deactivate clause. The first activates the SAVEREC() function (in EX1.PRG) to gather the memory variables back to the database record, the second returns an .F. telling FoxPro not to deactivate the read.

Below is an example of the deactivate code from screen MONTH2:

```
=SAVEREC()
RETURN .F.
```

(5) *Control Panel:*

All data entry screen handling procedures except for Delete and Restore, are controlled by the valid clause of the push buttons for the m.choice variable in the Control Panel.. (Delete and Restore are accessed from the pull-down menu to help users avoid using these functions accidentally when moving around the Control panel). This is a single do case structure with a separate procedure for each case. Selecting the first button activates choice=1, the second activates choice=2, etc...

■ FindRpt:

This deactivates the F3 key to select the control panel and runs the RPTFIND screen set which displays a scrolling list of all Report IDs. When a new record is returned by this screen program, the new record's ID is stored in a memory variable and the data from each file is then scattered to memory variables for editing.

(The only trick here is that the program must check to see if the center gives immunizations or not. If not, a blank set of memory variables must be displayed on screen 10 as a vaccination record is probably not created for this report). The when clause in the vaccination data entry screen MONTH10, ensures that the cursor is not allowed onto that screen when there is no underlying vaccination record.

■ Next:

Checks to make sure that the pointer is not already at the end of the file. If not, it skips to the next record and scatters all of the fields in each file to memory variables. Otherwise it displays the message "Already at bottom of file"

■ Prev:

Checks to make sure that the pointer is not already at the beginning of the file. If not, it skips back to the previous record and scatters all of the fields in each file to memory variables. Otherwise it displays the message "Already at top of file"

■ ErrChk:

Asks the user if the error report should be sent to the printer. If so it sets the printer on and then runs the error check procedure in ERRDOC.PRG. When the report is complete, it sets the printer off and re-selects the MONTHRPT file.

■ Add:

Changes the adding variable to true and selects the MONTHRPT file. It then scatters blank memory variables for each field in the record and activates the first entry screen placing the cursor in the inst_id field. (Note: In screen MONTH1, the when clause for the fields m.inst_id, m.rpt_month, m.rpt_year contain the expression: m.adding=.t. or m.ch_id=.t.. This only permits data to be entered into this field when adding or changing id-numbers.) All other processing of this function is controlled by the valid clause in the m.rpt_year field of screen MONTH1.

- Search:

Runs the SEAR_PROC included in the bottom of the control panel's valid clause. This displays a window with 3 search fields and then does a locate for based upon the data. If the record is found, the data is scattered to memory variables and redisplayed.

- ChgID:

This sets the memory variable ch_id to true and activates the m.inst_id field of screen MONTH1. The user is then permitted to change any or all of the 3 key fields. Checks for duplicates are contained in the MONTH1 screen set.

- Quit:

This checks to see if the user was adding or editing data. If not, the databases are all closed, windows are cleared and control returns to the main menu. Otherwise the data is gathered back to MONTHRPT and STKFLAT databases and the user is not allowed to quit. This avoids the potential problem of saving a partially entered key field.

After any one of these options is selected, the program re-displays the information on the last screen. Note: It needs to check to make sure that there was a window activated before the control panel in which case it re-displays the gets for that window only, otherwise it re-displays all of the gets for the screen set (this takes longer).

- ii. Error checking:

Error checking is done in a variety of ways in each of the modules of this system. The most common is through field level validation, where a validation procedure is built into the valid clause of an individual field in a screen set. Validation checks at this level include range checking for numeric values (e.g. RPT_MONTH must be between 1 and 12) and logic checks between certain dependent fields in the data entry screen.

In certain cases, the user must input redundant data as a check on the accuracy of data entry (eg. TOT_NC must be entered even though all of the new cases by age group can be summed up to give the same value. If this sum and the total entered do not correspond, the user is prompted to check the data that has been entered for data entry errors. If the data has been entered correctly, but the person filling in the form made an error in addition, then the computer operator can adjust the sum.

Wherever coded values are required for a field, validation is controlled through a lookup table of valid values. In most cases these valid values are stored in a separate .dbf file, so that they can be modified over time without re-compiling the software. In very few cases, these values are stored in an array created by the program and are thus not subject to change (e.g. Rural, Urban, Unknown, for geographic location). Wherever data entry is validated using lookup tables, the following demonstrates the procedure used.

The user enters a code in the screen code and tries to move to the next field. This is done through the following line in the screen code.

```
@ 12, 13 GET m.dist_code VALID chkdist()
```

In the valid snippet for the m.dist_code field the following function is executed:

```

FUNCTION: chndist  @@ institut.dist_code VALID

public mprompt
private mprov, mdist
mprov=mprovset1
mdist=institut.dist_code
set safety off

DEFINE POPUP popdist FROM 3,15 TO 19,46 PROMPT FIELD dist_name+ " "+dist_code
TITLE "District Codes"

** when a code is selected deactivate the popup
ON SELECTIGN POPUP popdist DO deactpop

** set up the lookup table and seek the data entered
select district
set order to tag dist_code
seek mdist

** if the data is not found or if the district code does not
** begin with the same number as the province code
if !found() .or. mprov<>substr(mdist,1,1)
    if mprov<>"7"          @@          <-----          only if not federal
        set filter to dist_code=mprov          <-----          only display
                                                districts in
                                                one province
    endif
    ** change the order of the district table to alphabetic
    set order to tag dist_name

    ** display the popup
    ACTIVATE POPUP popdist

    ** update the fields in the database
    replace institut.dist_code with district.dist_code
    replace institut.div_code with district.dist_code
    replace institut.prov_code with district.dist_code
    mdist=district.dist_code

    ** disable any filter
    set filter to
endif

** reselect the main database and redisplay the gets
select institut

show gets
RETURN .T.

** generic procedure to deactivate a popup once a code has been selected.
PROCEDURE deactpop

STORE PROMPT() TO mprompt
DEACTIVATE POPUP
RETURN

```

In addition to field level validation, the Monthly reports module has a special error check routine which is activated by the computer user directly from the control panel. This runs a procedure stored in ERRDOC.prg which checks about 30 logical inconsistencies in the data entered and displays the results for each monthly report with errors. Whenever an error is found in any section of the report, the error flag is changed to "E" in the corresponding section.

BEST AVAILABLE DOCUMENT

The error messages can also be printed out and sent with the original Monthly Report form back to the health institution for correction. This same procedure is also run on all the records in the monthly reports file prior to running the Log report, as this displays which of the monthly reports had errors.

iii. Batch Transmission:

A critical part of this distributed computer system is the batch process for data transmission. Data is entered at the most decentralized level possible and then sent on diskettes to the next higher level. The batch transmission procedure for all data is built into the Reporting module. The procedure has been designed to work the same way at whatever level it is used -- this avoids having to maintain different versions of the software for implementation at different levels.

The batch transmission process is divided into two key procedures: transmitting data to higher levels and downloading data which has been received on a batch diskette from a lower level. Both are automatic, and require little intervention from the operator.

In order to limit the amount of data transmitted, only those monthly and yearly report records which have been added or modified since the last transmission are sent. In addition, the entire institutions database is sent with each transmission. The selection of records to transmit is determined by the presence or absence of a batch number in the batch_no field of each monthly and yearly report record. When a record is first created the batch_no field is blank. During the transmission process, all records with an empty batch number are copied to a set of files in the ..batches subdirectory. These files are called B_MONTH, B_STOCK, B_VAC, B_YEAR, B_INST and B_POSTS. Once the copy operation is complete, a batch number is automatically placed in this field of the sending MONTHRPT or YEARRPT file by BATCH.PRG. Finally the data are compressed to floppy disks using the PKZIP procedure into a single BATCH.ZIP file, and a batch transmission report is written to a text file called contents.txt. This information is also stored in a memo field of BATCH.dbf, so that a history of batch transmissions can be monitored.

Once a diskette with batch data is received from a lower level computer center, the computer operator selects the option to download batch data on the Utilities menu. This runs the procedure contained in BATCHIN.prg. First, the diskette is checked for the presence of BATCH.ZIP. If the file exists, the contents of the batch report are displayed for the user, who must confirm that the data should be uploaded. The files are then copied to the ..batches subdirectory where they are de-compressed using PKUNZIP. Then each file is taken in turn and the following procedures are done:

- A relation is set between each master file on the receiving database and the corresponding B_ file.
- All records which match on the RPT_ID field are then deleted from the master file.
- Finally, all records from the B_ file are append to the master file.

Whenever a record is edited, the batch_no field is reset to blank by the SAVEREC() function which is called from every screen. This ensures that these records will be copied with the next batch.

iv. Archival:

The archival procedure removes all MONTHRPT, STKFLAT and VACFLAT records which are 2 years old. In order to preserve some of this data on-line for long term trend analysis, all records are first summarized by tehsil, inst_type, year and month using the procedure in MAKESUM.prg. Then these records are copied to files named MNTARC99, STKARC99, VACARC99 (where 99 is the last 2 digits of the year for which the reports were entered). Finally, a procedure very similar to batch transmission is run in which these files are compressed using PKZIP into a single file called ARC99.ZIP on a floppy diskette, an entry is made in the batch database, and an Archival report is displayed. This data can be restored for special analyses by using FoxPro interactively -- although this should only be done by experienced database users so as to avoid corrupting the main databases.

v. Data sets procedure:

This procedure has been developed to produce one of the following data sets:

EPI	all data related to Expanded Programme on Immunization which is transmitted through the Monthly Reports system.
TB	all data related to Tuberculosis laboratory testing, drug stock outs and case management from the Monthly Reports.
Malaria	all data related to Malaria laboratory examination, drug stock outs and case management.

Upon selecting one of these data sets from the Data sets sub-menu, the screen DATASET.spr is displayed for you to specify the parameters for the data sets to be created. This includes the period for which data is wanted, and the type of file that should be created.

The data can be output into one of the following file formats:

dbf	this is a dbase III+ compatible database file which can be manipulated in FoxPro, dBase or EPI Info.
wk1	This is a lotus 1-2-3 version 1A spreadsheet, which can be retrieved into Lotus, Quattro Pro or another electronic spreadsheet. Note: most spreadsheets cannot retrieve files with more than several thousand records, so this format may not be appropriate if you have a large data set to extract.
xls	This is a Microsoft Excel spreadsheet, which can be used directly in Excel. The same conditions apply as to wk1 files, above.
dif	This is a data interchange format file which is useful for transmitting data to a variety of file formats -- especially those used by databases on mini- or mainframe computers. This is a comma delimited ASCII text file, each field is delimited with commas and each record is followed by a carriage return.

This procedure creates a flat database file which includes selected key fields from the Health Institutions Database as well as those from the Monthly Reports data files. These fields include the Institution Name, Division, District, Province, Institution Type, etc... The files are created through a series of SQL queries which are contained in the MONTHLY menu code. The multiple queries are necessary because some individual SQL query statements are too long for FoxPro to handle. Currently, the user cannot select individual fields to copy, although this would be a worthwhile enhancement.

The procedure creates files beginning with EPIDS99, TBDS99, MALDS99 with the appropriate extension, depending upon the type of file desired. When the file is created, a dataset report can be printed or displayed on the screen which contains a data dictionary listing of all the field names, data types and a brief description of the contents of each field. This report is prepared by creating a temporary database using the COPY TO &mfile STRUCTURE EXTENDED command and then relating this file to the data dictionary file called MONTHX.dbf. Finally, the screen COPYTO.spr is displayed to let the user decide where to copy the resulting database files -- and whether or not to use compression when copying the file. If compression is selected, the data is copied using the PKZIP command, otherwise it is copied using FOXPRO's COPY FILE command. Once the copy process is complete, the original dataset files are erased from the hard disk to save space.

vi. Annual analysis:

The annual analysis procedure is designed to produce a variety of reports summarizing data from the previous year and analyzing longer term trends. Data for this analysis is drawn from Yearly and Monthly reports data as well as from the Health Institutions Database. Because data is only maintained on the system for a maximum of 2 years before archival, information on longer term trends is drawn from the annual summary files which are created during the archival process. In fact, to simplify reporting, even recent data is summarized in the summary files (MONTHSUM, STKSUM and VACSUM) by running the Update summary data option before printing the annual analysis reports.

The timing of the annual analysis process is important. It should not begin before computer centers have had a chance to enter corrected reports from December which have been re-submitted by health institutions whose reports initially had errors. Given the normal delays with data transmission and data entry, this can only begin at the end of April at the earliest.

The annual analysis procedure should begin by Updating summary data for the previous year. This calls the procedure stored in MAKESUM.prg, which begins by prompting the user to select a year for summarizing the data. The screen YR_SEL is displayed to display all years for which data can be summarized. Once a year is selected, the summary data files MONTHSUM, VACSUM and STKSUM are updated as follows:

- For each file, a temporary file containing only key fields and all the numeric fields which are to be totalled is used (MONTHTMP, STKTMP and VACTMP). These files also have fields which are 2 digits wider than the original fields so that the likelihood of data overflows is reduced when the totalling process creates numbers which are wider than the fields in the original data files.
- Data is appended to each these temporary files for the year for which data is being totalled.
- The rpt_id field is then transformed in each of these temporary files to contain the tehsil code, year, month and one of 4 institution types (BHU,RHC,MCH or OTH). This string becomes the key field to link the different summary records together later on.
- The temporary files are then indexed and totalled on the new rpt_id key field to a second set of temporary files (TMPMONTH, TMPSTK, TMPVAC). In addition, the number of institutions reporting and the reporting rate for each tehsil, month and institution type are calculated by running the CALC_RPTS procedure contained in MAKESUM.prg. These figures are then stored in the fields NUM_RPTS and RPT_RATE.

- Next the final summary files are used and all pre-existing summary records for the year specified for updating are deleted. Once this is complete all records are appended from the TMPMONTH, TMPSTK, TMPVAC files and the main summary files are packed.
- Finally, the temporary files are cleaned up. TMPMONTH, TMPSTK, TMPVAC are erased and MONTHTMP, STKTMP and VACTMP are zapped so that they do not take up any extra space on the disk than is needed.

The resulting summary files are about one-tenth the size of the original files, but all details at the health institution level are lost. Data analyses using this data can go no further than to the inst_type and tehsil level. They can, of course be aggregated to higher levels, such as district, division, or province.

Outputs from the annual analysis reports take 3 principal forms:

- summary tables comparing indicators or listing resources for the whole year by tehsil, district, division or province (produced by SQL queries and FoxPro report forms)
- graphs demonstrating trends over time by quarter or by month (produced by SQL queries and FoxGraph).
- maps displaying the geographic distribution of key indicators by district (produced by using SQL queries and EPIMAP)

Details about specific procedures used to generate these different outputs are included in the section on report generation methods and formats, above.

3. Possibilities of Future Expansion:

Any management information system needs to be flexible enough to adapt to changing management information needs over time. This is one of the reasons that the software has been designed in its modular format. Nevertheless, some parts of the system are, by definition, less subject to change than others. For example, before changing the screen layouts and adding other data to the Monthly and Yearly reports data entry screens, similar changes must be made to the reporting forms which are used to report the data from health facilities.

a. Adding new data entry modules:

If completely new reporting forms were developed (say for AIDS diagnostic reports from sentinel reporting sites), it would be fairly simple to add an additional screen set to the System menu pad. These screens can link to any of the existing data files given the following provisos:

- avoid changing the structure of the existing files as the removal of any fields would cause error messages when running the data entry procedures. Adding new fields is possible, but must only be done after careful consideration about what effect this will have on the size of the databases. Note, also, that some of the data is automatically updated with batches coming in from the districts, so any changes made at the higher level would be overwritten with data coming from previous updates.
- if a new screen set is added, be sure to update the data management procedures in the following files to take into account the new data files:
 - Delete and Recall menu options. Add a new CASE routine for each screen set to make sure that records from the correct data files are processed.

- Back-up, Reindex, Pack: Add the new database files to these procedures in the menu program.
 - Add a menu option to call your new screen set under the existing data entry options on the System menu pad.
- b. Adding new reports:

As new report formats are developed, either for the existing data or for new modules, they may be added to the Reports menu pad. It is important to maintain the hierarchy of report sub-menus already developed (e.g. Facility, District, Division, Province, Federal, Annual analysis) when any new reports fit into this scheme. If reports are developed for a completely new data entry module, it is wisest to add a completely new sub-menu into which are added all reports related to the new module.

Developers are encouraged to use the existing procedures to run reports for additional reports. See the section on report generation and formats above for more details on how this can be done. Wherever possible, it is encouraged to use SQL queries to create temporary files for reporting purposes as this is generally quicker and is less likely to result in damage to the main data files. This also avoids the need to create and maintain a very wide variety of index files and tags.