Student and Professional Understandability of Software Design Methodologies

by

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- INTRODUCTION -

There are many software design methodologies and every designer claims their methodology is the best, i.e. easiest to use or the easiest to understand. Yet with all of these methods there seems to be no general agreement as to which is best. There exists a need to investigate these software design methods. One way of determining the best methodology is by the ease of use or understandability of the designs.

There has been research on the understandability of code and specifications but none on the understandability of specific design methods. Tom Love[6] has researched the program structure's effect on comprehension within code. The subjects were asked to reconstruct the code. Woodfield, Dunsmore, and Shen[11] have done research on the effect of modularization and comments on program understanding. In this study the participants were to answer questions about the accompanying code. Sheppard and Kruesi[9] had subjects modify and debug code based on the associated specifications. The specifications were represented in different symbologies and spatial arrangements. Sheppard, Kruesi and Curtis[10] again examined the symbology and spatial arrangement of specifications. Instead of having the participants perform a coding task, they answered questions about the specifications.

Although these are important areas of research, it becomes pointless to investigate the understandability of code if that code is derived from a faulty design. The purpose of this study is to examine the understandability of software design methods. The participants were asked to answer questions about system structure diagrams which were produced using four software design methods.

The initial design of a system is an important phase of the software life cycle. Most software engineers would agree that if the system's design is faulty then the code is also going to be incorrect. If the designer does not understand the design method that they are working with then it is highly unlikely that they will produce a correct system design.

The hypothesis for this work is that of the four design methods tested, one will be understood better than the other three. Understandability is measured by the speed and accuracy with which the subjects respond to the questions. The design method that is tested to be best understood by the professional test group may not be the same as the method that the student participants understood best. The null hypothesis will be that all four design methods have equal understandability for both test groups.

As mentioned above two independent groups, students and professionals, were tested for their understandability of the design methods. The groups were selected as being representative of the personnel who use software design methods in industry. The professionals represent programmers that might use these methods on a daily basis. The students represent future users, who do not have a working knowledge of them. In industry users may be managers or end-users, anyone who needs the system and its functions communicated to them.

The reason for testing two groups is that, in industry, the software design methods have two uses. First, it is used as an aid by the programmer represented by the professional test group, in constructing a system design. By using a well understood design method, the programmers will tend to produce correct system designs, cutting down on expensive modifications. Second, the design method is used to help the programmer communicate their system design and its functions to the user represented by the student test group. If the user does not understand the design method then they might either approve an incorrect system design or continually reject correct designs. If a software design method can be determined as being well understood by both test groups then it can serve the programmer as a design tool as well as being an effective communication tool.

In this research, understandability is measured by speed and accuracy. One important factor in designing software is to produce it as quickly as possible. It could be argued that anyone could understand any design method if given enough time. The design method is not of much use if it takes a long time to understand it. In the experiment, speed is measured by the time that it takes the subject to answer the questions. The most important factor, however, is to produce quality software. This is more important than speed because of the high cost of maintenance and debugging. Accurate software, taking much longer to produce, would be better than quickly produced faulty software. Accuracy is measured in this study by the number of correct answers.

- EXPERIMENT DESIGN -

DESIGN METHODOLOGIES

The software methodologies that were tested are: Higher Order Software (HOS), Jackson's structured design, Warnier-Orr, and Yourdon-Constantine. These are all diagram-oriented methodologies.

HIGHER ORDER SOFTWARE (HOS)

An HOS diagram is a decomposition tree, that is, a tree of boxes where each box can be decomposed or divided into more sub-boxes. There are two possible types of decomposition: composition and partition. Composition is an 'and' function. All of the sub-boxes are performed. They are executed from right to left. Partition is an 'or' function. This is indicated by conditions associated with the arcs coming out of the decomposed box. The conditions are shown in brackets {}. Only the one box for which the condition holds true is executed. In order for an HOS diagram to show iteration, a recursive call to a module at a higher level is performed [3],[4].

JACKSON (JACK)

The Jackson method is based on the structure of the inputs and the structure of the outputs. Each is described in terms of a series of boxes. The structures are then combined to form the software structure of the whole system. There are three possible types of structures within a Jackson diagram: sequence, condition and repetition. A sequence is a box that contains no special symbol and has more than one box below it i.e. a sequence of boxes are executed. This sequence of boxes is performed from left to right.

A condition structure is designated by the 'O' symbol in the upper right corner of the box. The box is executed based on some condition. This can also be called a selection. One of the sub-trees is selected based on some condition.

A repetition structure is designated by the '*' symbol. This indicates iteration, the sub-tree below this box will be performed multiple times. This looping is continued until the end of some iteration condition. A structure may also be referred to as a module [8].

WARNIER-ORR (W-O)

A Warnier-Orr diagram structure is described using brace notation. Each brace has a name that labels the brace; the name appears to the left of the brace. To the right of the brace is a list of entries that comprise the body of the brace. Each entry can be further expanded with another brace. The brace can be interpreted as a call to the body of the brace. A brace can also be referred to as a module.

A notation below a brace name or entry indicates the number of times that particular brace or entry will be performed. This notation can indicate repetition by '(1,n)?1', which means that it is executed 1 to n times. The '?1' is a footnote reference which gives the condition that ends the repetition. An exclusive or relationship is indicated by two notations. First, there will be a notation under each name or entry, that is to be ORed. This will be in the form of '(0,1)?2', it will be executed 0 or 1 times based on the condition referenced by '?2'. Second, there will be a '⊕' symbol between the names or entries that are to be ORed. One of the two or more modules will be executed based on the referenced conditions.

If an exclusive or relationship is not represented then an and relationship is assumed. These names or entries are executed from top to bottom [3],[5].

YOURDON-CONSTANTINE (Y-C)

The Yourdon-Constantine diagram is produced from a data flow diagram. The data flow diagram is transformed into a hierarchy diagram. The resulting hierarchy diagram represents the flow of the data through the system. Data is indicated on the arcs, between the boxes, with an arrow showing the direction of flow.

The top box is called "MAIN". There are possibly three sections below the main, these are: afferent, efferent and transform sections. They can be thought of as input, output and processing, respectively. Each can be represented as one box or many boxes.

The leftmost section is the afferent. These boxes can usually be identified by the term "GET". There is often one box for each major input. Users can be indicated by a box with a slash in the bottom right corner. A users box means that interaction with the user occurs here.

The middle section is the transform. These boxes perform the main action or processing within the system. One type of transform module can be identified by the term "CONTROLLER". Based on some data, it controls or selects which of the sub-modules should be performed.

The rightmost section, if it exists, is the efferent. These boxes can usually be identified by the term "PUT". There is often one box for each major output. Again, user boxes can be indicated here.

The three sections of afferent, transform and efferent can be continued recursively down the tree. That is, a transform module can have below it an afferent, transform and efferent section. An afferent module below any module can be grouped with the afferent on the far left. Also an efferent module below any module can be grouped with the efferent on the far right.

The Yourdon-Constantine design method described here is the transformational type. There is also a transactional type of diagram that was not used in this study. For more information on the transactional type of Yourdon-Constantine diagram see "Structured Design: Fundamentals of a Discipline of Computer Program and Systems Design"[12].

DIAGRAM SYSTEMS

Each subject will be tested on all four methods; therefore, four different systems were needed. The systems that are being used are as follows: Savings Account Monthly Report System, Student Advisory System, Country Club system, and a Project Manager System.

SAVINGS ACCOUNT (SA)

The Savings Account System is designed to run at the end of each month. It reads in files for each savings account; does the appropriate bookkeeping for month-end transactions, such as interest payments and finance charges. Then it produces a Monthly Savings Account Report to be sent to each account holder. This is a report type system [5].

ADVISING (AD)

The advising system is designed to aid in advising a student of which classes they should take. The files it accesses are an Arts & Sciences requirements file, a core requirements file, a suggested four year progression file and a technical elective options file. There are also files on what the student is taking or has taken, these include an Arts & Sciences courses file, Core courses file and technical electives file. The student can make various additions, deletions, and changes to their own files. They can also print out various reports using their own files or the system files. This is a menu driven system with some file management.

COUNTRY CLUB (CC)

The Country Club System is designed to maintain the members' file. This includes adding transactions to a member's record, adding, changing and deleting a member's record. Other items this system does, but are not detailed on the diagrams here, are produce billing statements, list members, and produce a sales report. This system does processing of interactive transactions. It is a menu driven system with some file management.

PROJECT MANAGER (PM)

The Project Manager System is designed to allow the manager of a project team to enter components (tasks) of a project and then see various management reports. The components contain an id, keyword and data. They can be added, deleted or changed in an editor. The system then runs a trace of the project and if it succeeds, the manager can select several management reports to be printed. This system is a combination of the above three systems. It is menu driven with an interactive editor. It also performs a trace and reports the trace results.

QUESTIONNAIRES

The questionnaires consisted of ten questions. Each question has three to four multiple choice answers. The ten questions are the same for each system, some of the multiple choice answers vary for the particular design method. When writing the questionnaires the main goal was to test the subjects on the diagrams. The subjects should have to refer to the diagrams in order to answer the questions correctly. It was determined that there were four types of questions that could be asked.

EXTERNAL BEHAVIOR (EB)

External behavior questions would ask general questions about what the overall behavior of the system would be like.

To answer this type of question correctly the subject would have to read and understand the system as a whole, from the design diagram. Most of these questions not only were the same for each system, but the answers were the same for all design methods. The overall behavior of a system does not change because of the design method used to show that system.

LOCATION OF ACTION/DECISION (LOC)

There are questions on the location of where some action is performed or where a decision is made. These questions will test the subject's ability to trace the design method. The subject will have to locate one section or module within the design in order to answer this type of question correctly.

CONTENTS OF FILES/OUTPUT (CON)

Questions on the contents of files or output, will also test the subject's ability to follow the design method. This question type also allows insight as to which design method clearly gives the subject an understanding of the files that the system uses or of the output that the system produces.

MODIFICATIONS (MOD)

For the subject to have a complete understanding of a design method they must be able to change or add to the diagram. This is the last type of question to be asked which is where or how a modification should be made. Modifications are somewhat a judgment decision. For a particular modification to a system there is never one absolutely correct solution. The subject's ability to make this type of judgment decision was not what was to be tested. Because of these reasons, the answers to the modification type questions were constructed in such a way that only one of the answers could be correct. The incorrect answers would cause either the system or the modification to be incorrect.

TRAINING

Before each subject was tested over a particular method they were given a brief training session. The training session consists of a design method description, an example diagram and training questions. The system which was used for all of the example diagrams, is the game Othello. It was selected in the hope that the complexity of the training would not affect the results of the actual test.

OTHELLO (OT)

The system was designed to automate the Gabriel Industries, Inc. version of the game Othello. The object of Othello is to have more pieces on the board than your opponent. Players take turns placing their pieces on an 8 x 8 game board. When a player puts his piece down in such a way that one or more of his opponents pieces are touched on both ends by the first player's pieces, the opponents pieces are then captured. Capturing can be done in one or more of the following directions, up, down, left, right or at any four diagonals. The captured pieces are flipped to the opposite color. Only the plays which capture opposing pieces are legal moves. Play is continued until neither player can move [1].

TRAINING QUESTIONS

Four training questions are given in each design method training session. The questions were written to accomplish two goals. First, the questions reiterate the main characteristics of the particular design method, explained in the design method description. Second, the questions were designed to familiarize the subject with the form and types of questions that are on the actual questionnaires. Only three of the four types of questions are presented. The question types included are an external behavior type question, two location of an action or decision type questions and a modification type question. There is not a contents of files or output type question because the Othello system does not contain files or report output. This is why there are two location type questions given, this type of question is the closest in form to the missing contents type question. The subjects are not asked to answer the training questions, instead they are given the correct answer with an explanation. The subjects are given the option of repeating the training questions as many times as they wish. The whole training session, however, is timed.

SUBJECTS

The subjects were students and professionals. The students were undergraduate and graduate level computer science students, who may or may not have seen any of the design methodologies before the experiment. Even though the students may have seen the design methods before, they have not worked with them extensively.

Nineteen of the student subjects were from the same undergraduate computer science course, CMPSC 420 Operating Systems. The packets were given to these subjects as an assignment to be completed in a week. When completing the test, they were given points for the course. The subjects knew that the instructor would not be given the results, he was only told if they completed the test or not. They were told to try to answer the questions as best as they could but not to panic if they did not know the design method because that was why they were being tested.

Three of the student subjects were from a different undergraduate computer science course, CMPSC 300 Algorithmic Processes. The instructor for this course made an announcement to the class asking for volunteers. These subjects were not rewarded for completing the test, they did it on a voluntary basis only. They were not given any time restraints, only asked to complete it as soon as possible. These three subjects were also told that the reason they were being tested was because they did not know the design methods but to try to answer the questions as best as they could.

There were still two more subjects needed to complete the twenty-four student subjects required. These were graduate students who were approached individually and asked to help out. These subjects were not rewarded for participating in the test. They were not given any time limit only asked to do the test in their spare time. These two participants were only told how to start the system, the test does have an introduction explaining the importance of speed and accuracy.

The professionals were programmers who work in the computer science field. The professionals also may or may not have seen all of the design methods before, but they have probably seen or used at least one of the methods through work experience. All of the professional subjects were currently working on graduate degrees. These subjects were approached individually and asked to participate as volunteers. The professionals were not rewarded in any way for participating in this work. They were told nothing about the test beforehand.

EXPERIMENT

Twenty-four subjects from each test group were needed. This was to ensure that the order, in which the subjects saw the designs, was not a factor. Combining the systems and design methods created sixteen different diagrams. Each subject saw all four systems and all four design methods. Every possible combination of the four methodologies was done, as shown in figure 1.

The systems were always presented in the same order so that the order of systems was not a factor. The order in which they were always presented was Savings Account, Advising, Country Club and Project Manager. This particular order was selected because of their probable familiarity to the subjects. Most anyone would be familiar with a Savings Account. Since the subjects were currently students, they would be somewhat familiar with the Advising system. The Country Club system was a typical file management system with which computer science students should be at least vaguely familiar. Probably few of the subjects were familiar with the Project Manager system.

Subject Number	Savings Account				Advising				Country Club				Project Manager			
	HOS	Jack	W-O	Y-C	HOS	Jack	W-O	Y-C	HOS	Jack	W-O	Y-C	HOS	Jack	W-O	Y-C
1	1					2					3					4
2	1					2						3			4	
3	1						2			3						4
4	1						2					3		4		
5	1							2		3					4	
6	1							2			3			4		
7		1			2						3					4
8		1			2							3			4	
9		1					2		3							4
10		1					2					3	4			
11		1						2	3						4	
12		1						2			3		4			
13			1		2					3						4
14			1		2							3		4		
15			1			2			3							4
16			1			2						3	4			
17			1					2	3					4		
18			1					2	.	3			4			
19				1	2					3					4	
20				1	2						3			4		
21				1		2			3						4	
22				1		2					3		4			
23				1			2		3					4		
24				1			2			3			4			

FIGURE 1

Each diagram was tested by six different subjects. Each method appeared in the first position, second position, third position and fourth position six times. The training for each methodology was done immediately before that method was tested. Since all four of the diagrams that the subject had, were over different systems and different design methods there was no possibility of training from one diagram to the next. The subject could not learn anything from previous diagrams that would help them on the current diagram.

Understandability, as mentioned earlier, was measured by speed and accuracy. There were two mean times associated with each diagram, these were training and questionnaire time. The training time is the sum of the time spent on the Othello system description, the design method description, the training questions and the system description. The training time is a sum of these individual times. The time that the shell program takes to display the descriptions to the screen is not included. The timing begins when the description is completely displayed and timing stops when the subject hits return to continue.

The questionnaire time is the sum of the ten response times for each questionnaire. Timing begins after a question is scrolled onto the screen and the timing stops when the subject enters a letter representing one of the multiple choice answers. The subject may type a letter, backspace and change that letter as many times as they wish, the answer is not entered until they hit return. The next question is then scrolled onto the screen and timing begins again. This is continued for all ten questions on the questionnaire.

Accuracy was measured by the mean number wrong. The number missed on each questionnaire were totaled. These totals were then used to calculate means for each of the sixteen diagrams, each of the four systems and each of the four design methods. Each of the sixteen diagram means are the average of six totals. The four mean numbers for the systems are an average of twenty-four totals, as are the four mean numbers for the design methods.

TEST SYSTEM

The diagrams, questionnaires and training all fit together to make up the test system. The test system was implemented as a shell program. This was done for several reasons. The main reason being that it would ensure that all subjects were treated the same way. Also the shell program could easily time the response and collect the data. The data from the shell programs could be manipulated and analyzed easily. Finally, with the test system automated, the subjects could take it at any time.

The shell program asks for the user's subject number (1-24) and from this number it determines the proper order that this particular subject should receive the design methods.

Each subject was given eight packets labeled "TRAINING ONE", "DIAGRAM ONE", "TRAINING TWO", "DIAGRAM TWO", "TRAINING THREE", "DIAGRAM THREE", "TRAINING FOUR", and "DIAGRAM FOUR". The training packets contained a brief description of the Othello system, a brief description of that particular design method and the Othello system drawn with that design method. The diagram packets contained a brief description of the particular system and the diagram that they were tested over.

When the shell program begins, a brief explanation of the experiment is given. All subjects were then asked background questions. Items that were asked, are "List the computer classes that you are taking.", "Have you seen an HOS diagram before?", "Have you seen a Jackson diagram before?", "Have you seen a Warnier-Orr diagram before?", "Have you seen a Yourdon-Constantine diagram before?"

After the introduction, the subject was asked to examine the packet labeled "TRAINING ONE". The shell program then displays the system and diagram descriptions, these are both included in the training packet but they were displayed to ensure that the subjects would read them. The descriptions are followed by sample questions with accompanying explanations of the correct answer. The subjects were given an option to go through the sample questions as many times as they like and the entire training session was timed.

Following the training, the subjects were asked to examine the packet labeled "DIAGRAM ONE". The shell program then displays the system description on the screen followed by the actual questionnaire. Each question on the questionnaire was timed and graded. It is assumed that speed and accuracy imply understandability. At the end of the questionnaire they were asked to rank the ease of use of this method on a scale of one to five, ranging from excellent to terrible, respectively.

When they finished with the first design method, the shell program asks them to examine the packet labeled "TRAINING TWO". The descriptions, sample questions, examine packet labeled "DIAGRAM TWO", and questionnaire are repeated the same as for design method one. They are also repeated for methods three and four. At the completion of all four design methods the subjects were asked which design method they preferred.

- RESULTS -

Organization

The results include mean times, mean errors, percent wrong, design method ratings and design method selection. The combined results are the combined numbers for both test groups, all forty-eight participants. The two test groups results will also be presented separately, twenty-four professionals and twenty-four students.

Mean Times

The mean times, for the training and for the questionnaire, are indications of the understanding of the diagram. Trends for both test groups can be seen in the combined results of the mean training and questionnaire times. Diagrams 1 and 2 show the mean training and questionnaire times for the combined results. The order in which the all-methods times decrease is Savings Account, Advising, Country Club and Project Manager. This is the same order in which the systems were presented. There are three possible reason for this trend. First, they may have learned from previous diagrams, but since each diagram seen by a subject was different in both system and design method, this was not possible. Second, the subjects may have gotten tired as the test progressed and began entering answers

Mean Time - Training
Combined Results

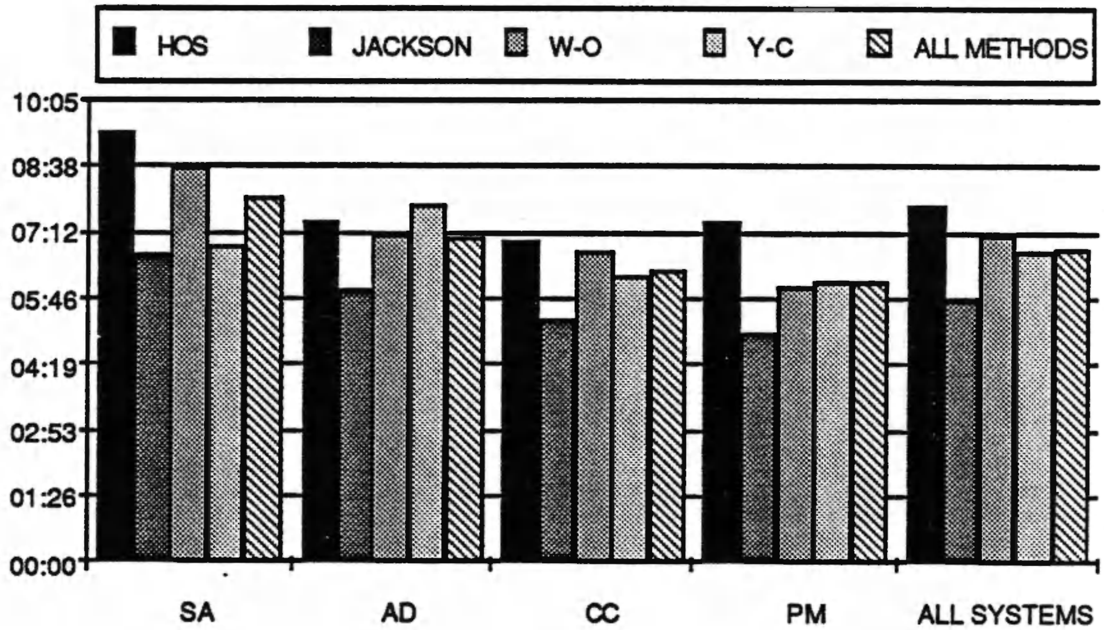


DIAGRAM 1

Mean Time - Questions
Combined Results

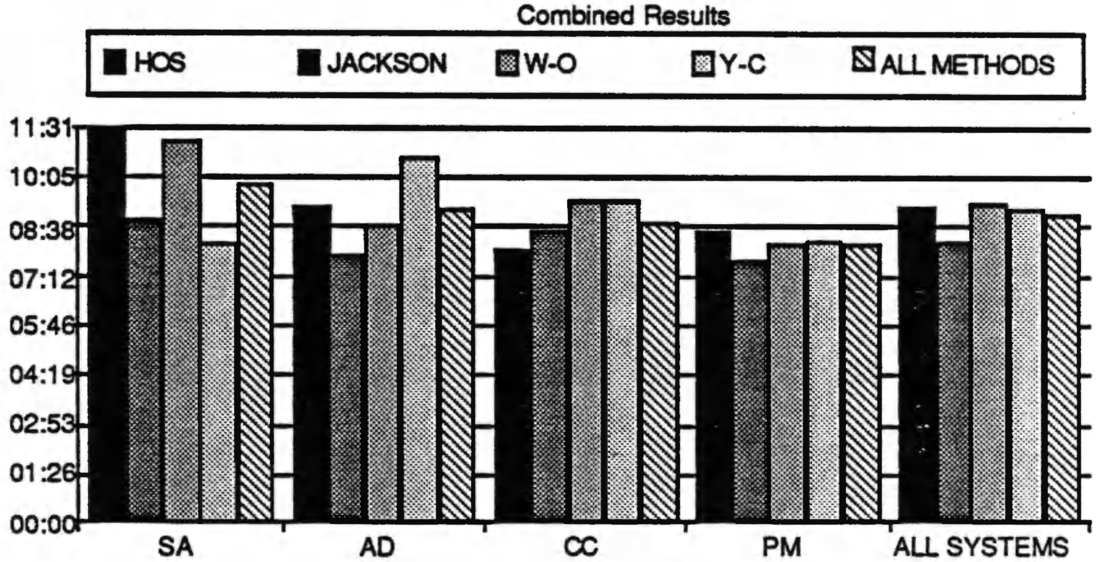


DIAGRAM 2

randomly. Third, the systems were presented in order from the familiar to not familiar. The subjects may have interjected their own assumptions about how the more familiar systems should run. The reason this would give them longer times is what the subject thought was correct would not match the question or the multiple choice answers. These assumptions would block the subjects ability to understand the diagram as it was presented. We will show that this third possible reason is probably correct when we examine the trends in the mean number of errors in the next section.

The design method's training times decrease in the order of HOS, Warnier-Orr, Yourdon-Constantine and Jackson as seen in diagram 1 for all-systems. The descending order for questionnaire times is Warnier-Orr, HOS, Yourdon-Constantine and Jackson.

The mean times for the professionals show slight differences from the combined results. The trend by system for the professional's training and questionnaire times is similar to that of the combined results, as can be seen in diagrams 3 and 4. The system times decrease in the order as which they were presented. Again, the possible reasons for this trend is that either the professionals tired while taking the test or they interjected their own assumptions, as discussed above. By design methods the times for both

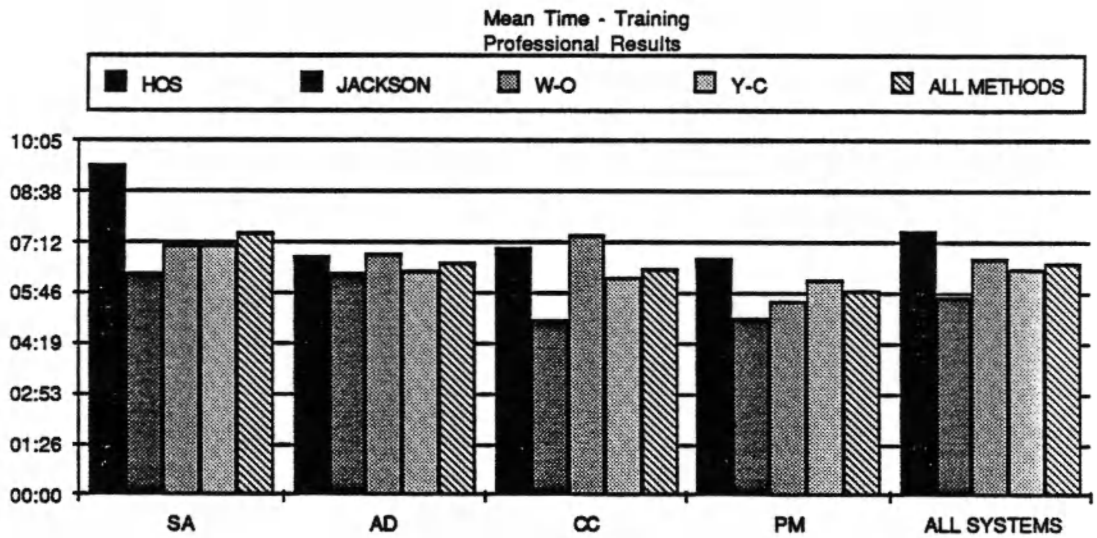


DIAGRAM 3

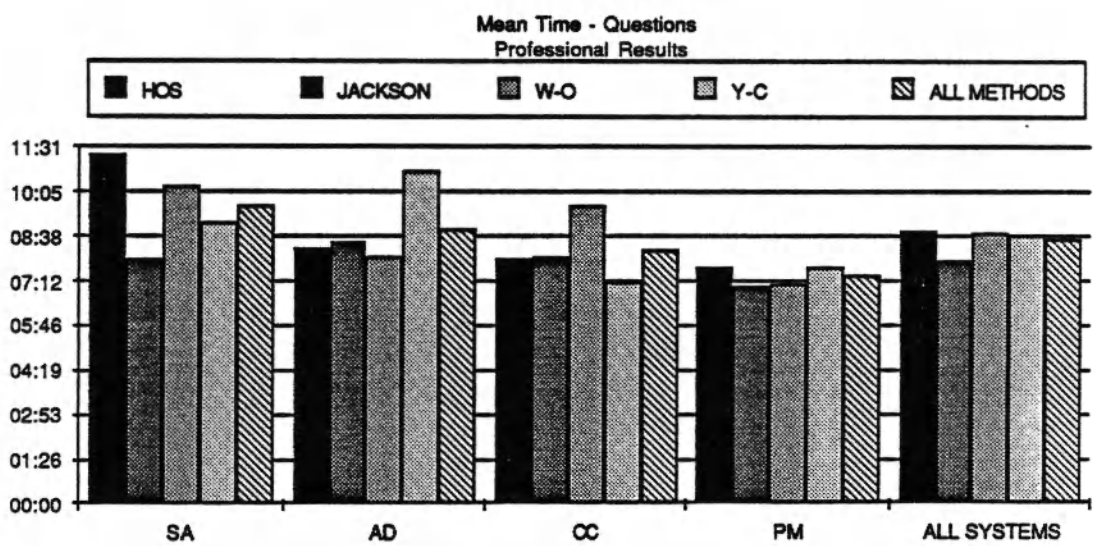


DIAGRAM 4

training and questionnaire decrease in the same order which is HOS, Warnier-Orr, Yourdon-Constantine and Jackson. Most of the professional times are lower than the combined by less than a minute. A few of the professional times were higher than the combined. These are Yourdon-Constantine Savings Account, Jackson Advising, and Warnier-Orr Country Club in the training times. For the questionnaire times they are Yourdon-Constantine Advising, Jackson Advising, and Warnier-Orr Country Club.

The student results of mean times have differences from both the combined and professional results. The student results for training and questionnaire times are displayed in diagrams 5 and 6, respectively. The mean times by system do not decrease in the same order as that the systems were presented. This is a distinct difference from the combined and professional results. Looking back at the possible reasons for the professionals' times we could see possible reasons for the students' trends. First, the student subjects may not have tired as easily but there is nothing to support this and it is highly unlikely. Second, the programmers were making assumptions about the more familiar systems, the students may not have assumed as much about the systems since they were not as familiar with the design methods. The order in which the training times decrease by design method is HOS, Warnier-Orr, Yourdon-

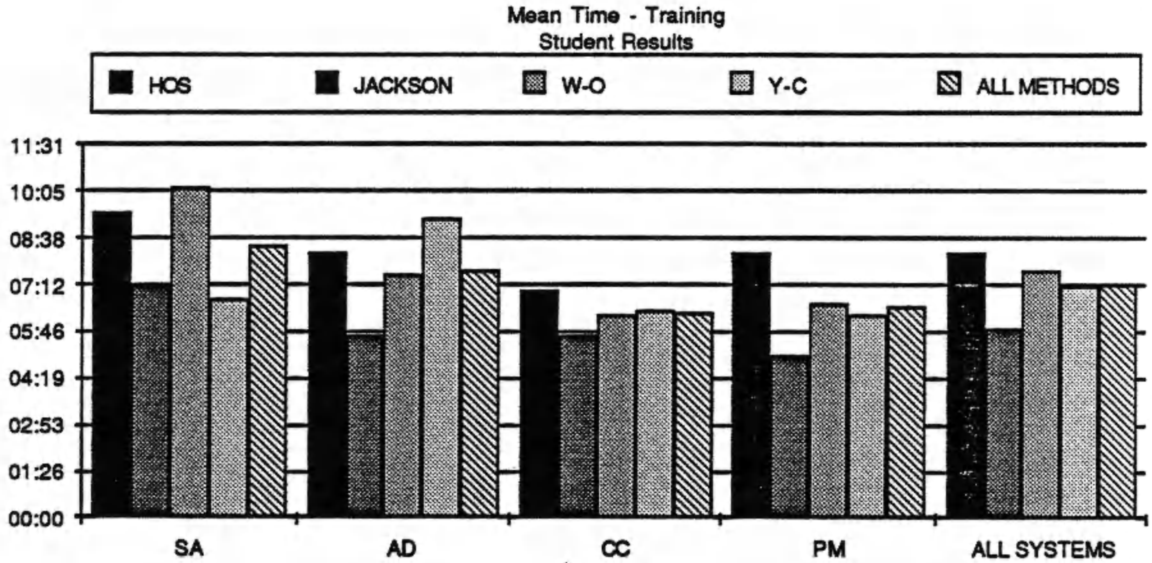


DIAGRAM 5

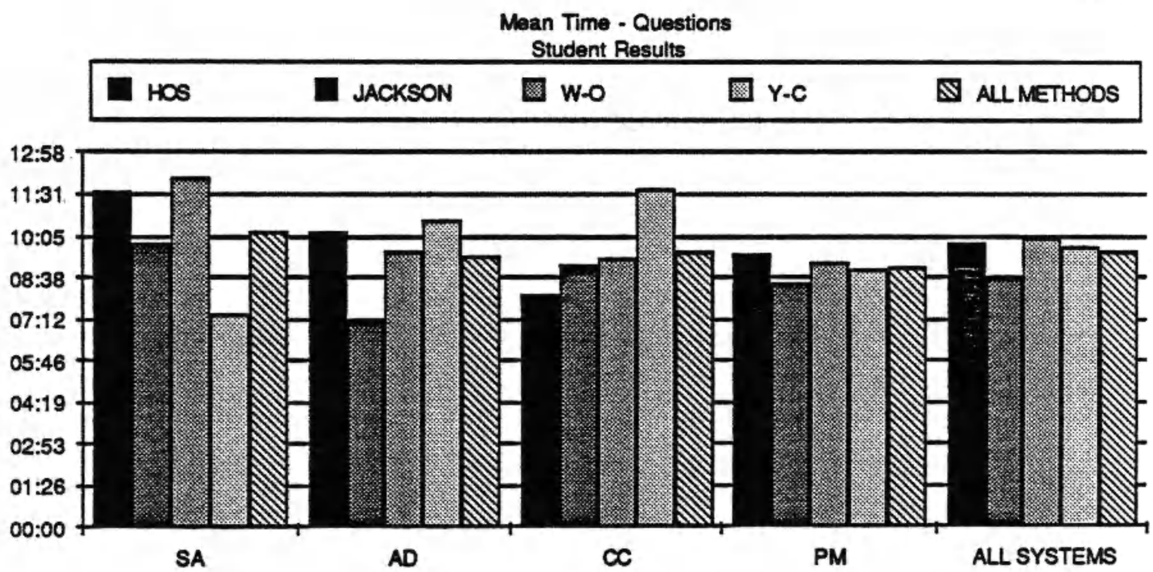


DIAGRAM 6

Constantine, and Jackson. The decreasing order of the questionnaire times for the student is different than that for the professional; it is Warnier-Orr, HOS, Yourdon-Constantine and Jackson.

Mean Errors

Another indication of the understanding of the diagram is the mean number of errors per questionnaire. The combined results reflect the overall mean number of errors for all forty-eight test participants. The mean number of errors for the combined results are shown in diagram 7. By system, the mean number wrong decrease sharply in the same order that the systems were presented, Savings Account, Advising, Country Club, and Project Manager. This shows that the subjects did not get tired but instead made assumptions. The subjects jumped to conclusions when they thought they knew the system, making the questions more difficult to answer. The mean number of errors by design method decreases in the order of Yourdon-Constantine, Warnier-Orr, Jackson and HOS.

Professional results for the mean number of errors show similar trends as the combined results with slight variations. The professional results in diagram 8 show that the mean number wrong by system, decrease again in the same order that the systems were presented. The decreasing order by design method is Yourdon-Constantine, Warnier-Orr,

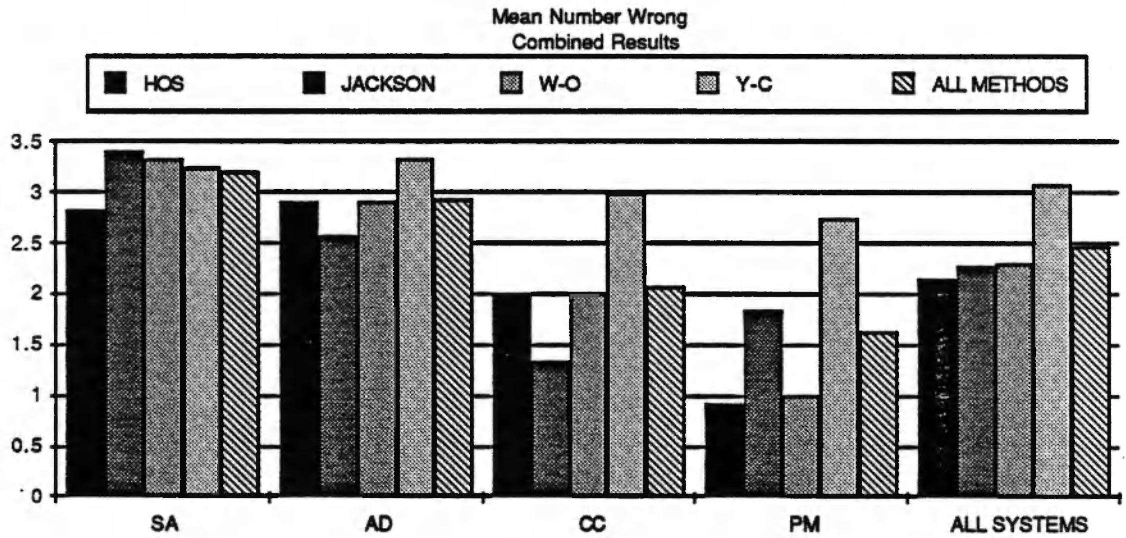


DIAGRAM 7

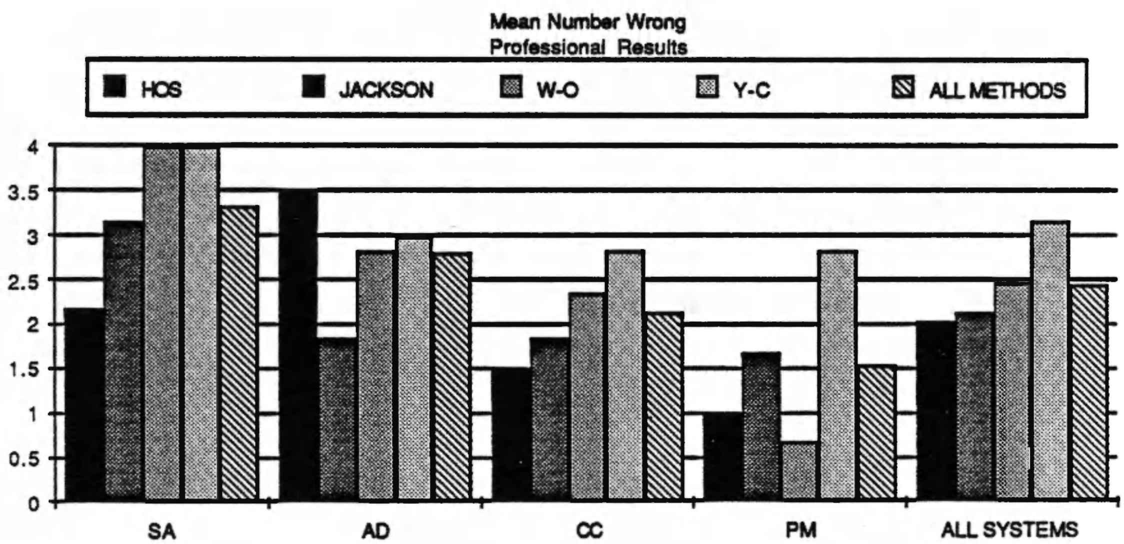


DIAGRAM 8

Jackson and HOS. An interesting point here is that HOS has the least wrong and it had the longest questionnaire time. Yourdon-Constantine was consistently high in all systems especially in the Savings Account system where it tied for the highest mean number wrong over all of the diagrams. The Warnier-Orr design method varied the most. In the Savings Account system, it tied with Yourdon-Constantine for the highest mean number wrong over all of the diagrams. The Project Manager Warnier-Orr diagram had the lowest number wrong over all of the diagrams. The systems in the Jackson method were between 1.5 and 2.0 mean number of errors with the exception of the Savings Account system which was above 3.0 errors. This was a very interesting result because the Savings Account system was a report type system. Jackson was designed specifically for report type systems. For HOS the mean number wrong was fairly low for all systems with the exception of the Advising system.

The mean number of errors on the diagram systems, for students, are similar to the combined and professional results but the trends for the mean number of errors on the design methods show differences. As seen in diagram 9, the mean number wrong by system decreases in the same order as presented, again. The systems do not decrease sharply however, Savings Account and Advising are even tied at 3.083333 mean number wrong. This supports the possibility

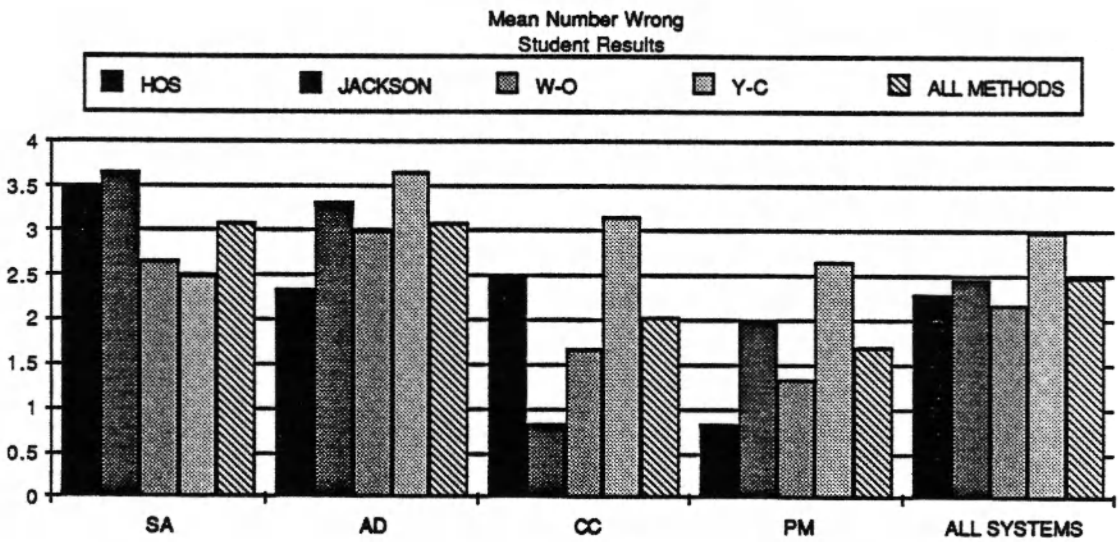

Mean Number Wrong
Student Results
HOS
JACKSON
W-O
Y-C
ALL METHODS
4
3.5
3
2.5
2
1.5
1
0.5
0
SA
AD
CC
PM
ALL SYSTEMS

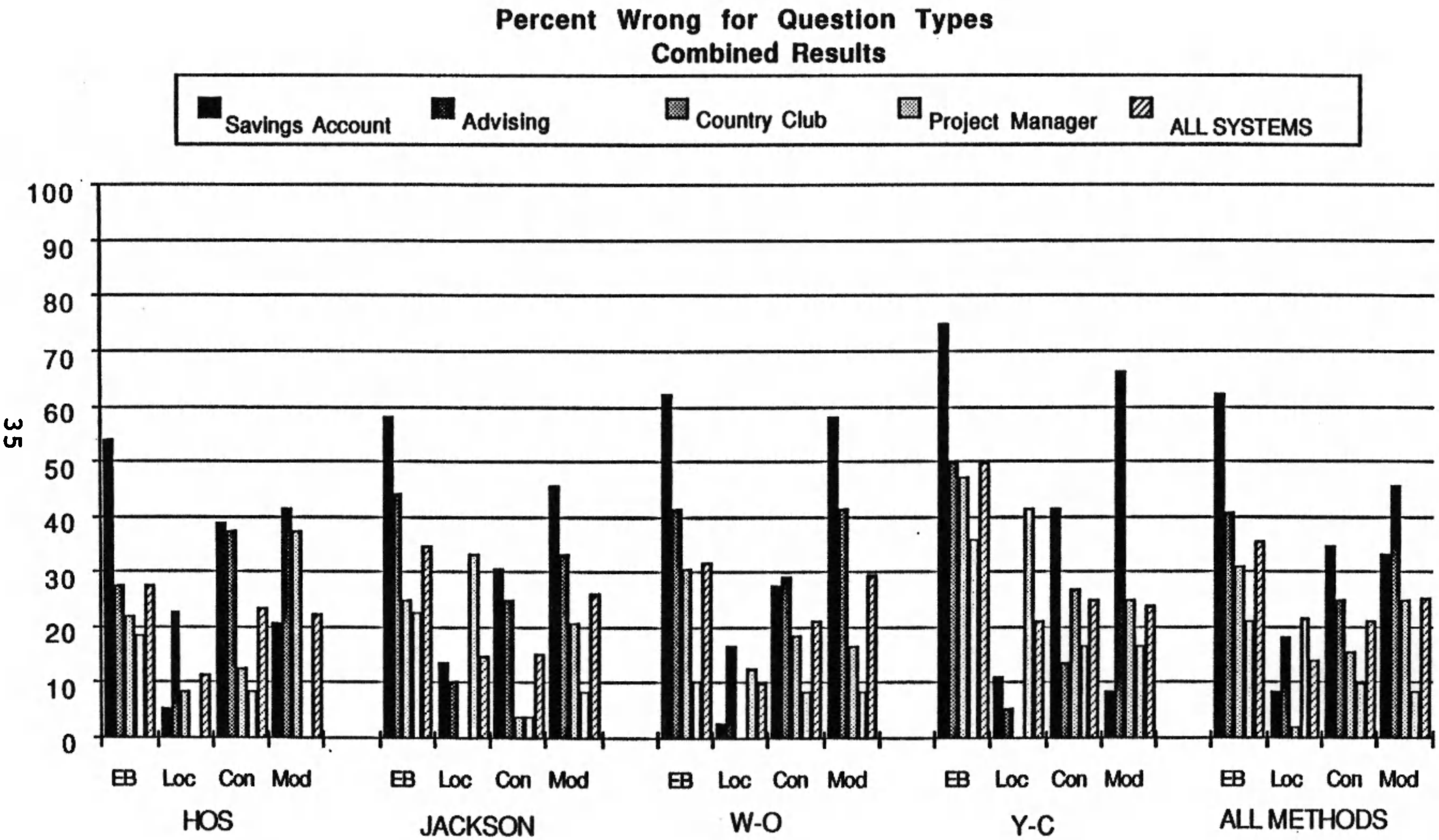
DIAGRAM 9

that the students made some assumptions but since they were not as familiar with any of the systems as the professionals, their assumptions did not carry as much of an impact. The systems were basically equally familiar to the student subjects. The design methods are not in the same order of number of errors for the students as they were for the professionals. Yourdon-Constantine, Jackson and HOS are in the same order with Warnier-Orr moving up to the least mean number of errors. The design method with the least wrong, Warnier-Orr is also the design method with the longest questionnaire time. Breaking the design methods out by system we can see the following results. The Yourdon-Constantine method again was consistently high in all of the systems. The Yourdon-Constantine for the Advising System tied for the highest mean number wrong. Jackson tied for both the highest and the lowest mean number wrong, for the Savings Account and Country Club systems, respectively. Jackson again did the worst on a report type system. The highest system for the HOS design method was Savings Account. The lowest number wrong was tied: the HOS Project Manager diagram and the Jackson Country Club. The Warnier-Orr method was second lowest in all systems which made it the most consistent and the lowest design method over all systems.

Percent Wrong for Question Types

The percent wrong for question types, is an area of interest that can give insight as to where the lack of understandability lies within a design method. The four question types on the questionnaires (external behavior, contents of files or output, location of an action or decision, and modification) are measured for the percent wrong of each type of question. The percentages are represented on diagrams 10 through 18. Each result group, combined, professional and student, has the percentages represented by three different diagrams. On the first diagram, "Percent Wrong for Question Types" there is a three way break out, these are by system, design method and question type. The second diagram, "Percent Wrong for Question Types by Design Method" has a two way break out, by design method and question type. The third diagram, "Percent Wrong for Question Types by System" also has a two way break out, by system and question type.

Combined results show what type of questions are the most difficult to answer correctly. The three diagrams for the combined results are diagrams 10 through 12. The "All Methods" for "All Systems" totals can show which type of questions were most difficult to answer. The subjects had the most difficulty on external behavior type questions. They did not understand the overall behavior of any of the diagrams. The second most difficult type of question for



Percent Wrong for Question Types
Combined Results
Savings Account
Advising
Country Club
Project Manager
ALL SYSTEMS
100
90
80
70
60
50
40
30
20
10
0
EB Loc Con Mod
HOS
EB Loc Con Mod
JACKSON
EB Loc Con Mod
W-O
EB Loc Con Mod
Y-C
EB Loc Con Mod
ALL METHODS

DIAGRAM 10

the subjects was modification. Third and fourth in difficulty were the contents of files or output and location of action or decision type questions, respectively. This shows that the subjects could trace most of the diagrams but did not understand them as a whole.

On diagram 12, external behavior and contents of files or output decrease in the order that the systems were presented. Modifications decrease in this order with the exception of Savings Account. Location of action or decision decreases in the order of Project Manager, Advising, Savings Account and Country Club. This indicates that the areas which the subjects made assumptions on was the external behavior and contents of files or output.

On diagram 11, the problem areas within each design method can be seen. All of the design methods did worst on external behavior type questions and best on location of action or decision type questions. HOS had the lowest percentages for external behavior and modification type questions. Warnier-Orr was best on location of action or decision type questions. The lowest percentage for contents of files or output type questions was the Jackson method. Yourdon-Constantine had fifty percent wrong on external behavior type questions. This indicates that when it came to the overall behavior of a system done using Yourdon-Constantine the subjects guessed at how it worked.

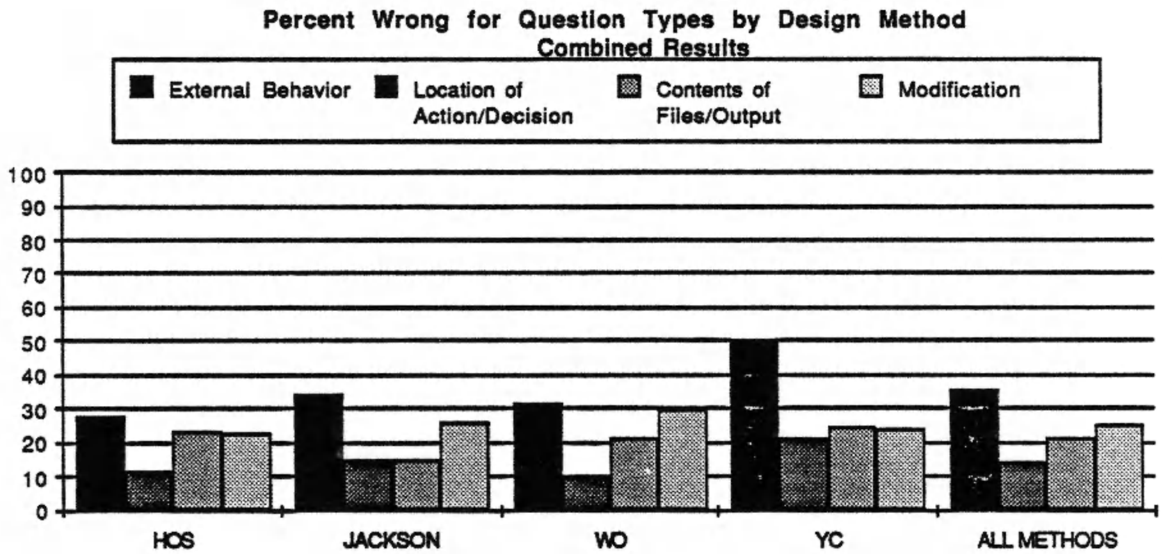


DIAGRAM 11

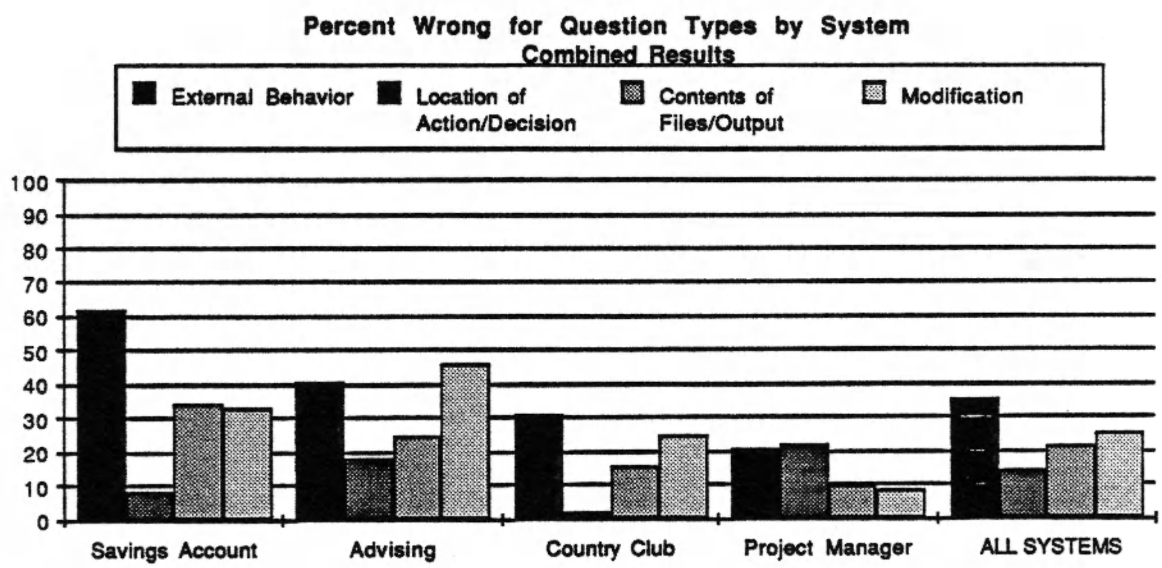


DIAGRAM 12

The professional results reflect the areas in which a design method is not understood and which design method is understood best for each particular question type. The professional results are shown on diagrams 13 through 15. The professional subjects again had the most difficulty on external behavior and modification type questions.

By system, diagram 15, the external behavior and contents of files or output decrease in the order of Savings Account, Advising, Country Club and Project Manager. The modification type questions were extremely high for the Advising system as was the external behavior type questions for the Savings Account system. None of the professionals missed any location of action or decision type questions on the Country Club system diagrams.

Diagram 14, shows the trends for the design methods. HOS did the best on external behavior and modification type questions. Warnier-Orr had the lowest percent wrong for location of action or decision type questions and the highest for contents of files or output. The Jackson method did best on contents of files or output type questions. Yourdon-Constantine did the worst on external behavior, modification and location of action or decision.

Looking at more detail on diagram 13 we can see what caused Jackson to do worst on the report type system.

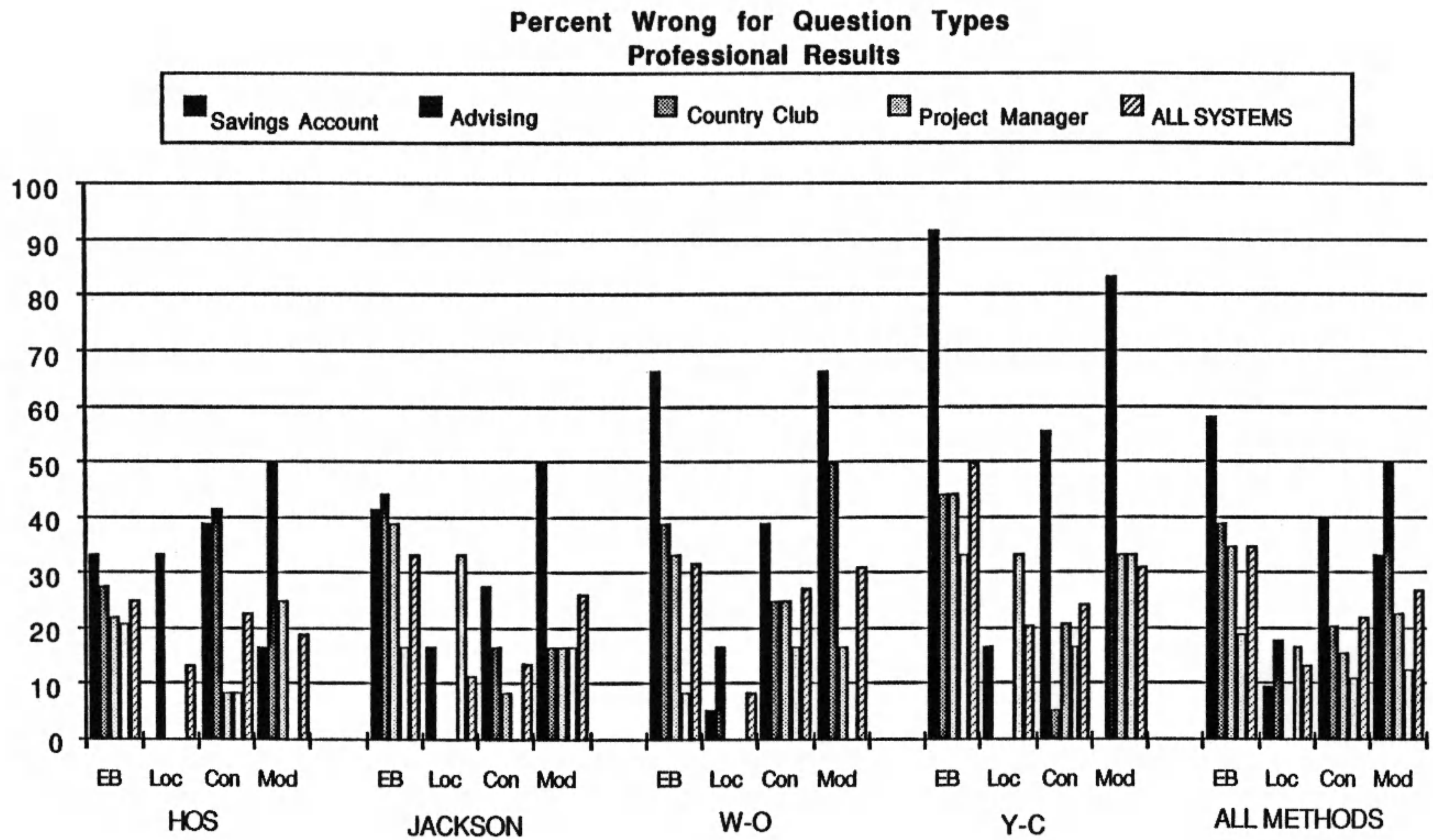

Percent Wrong for Question Types
Professional Results
Savings Account
Advising
Country Club
Project Manager
ALL SYSTEMS
100
90
80
70
60
50
40
30
20
10
0
EB Loc Con Mod
HOS
EB Loc Con Mod
JACKSON
EB Loc Con Mod
W-O
EB Loc Con Mod
Y-C
EB Loc Con Mod
ALL METHODS

DIAGRAM 13

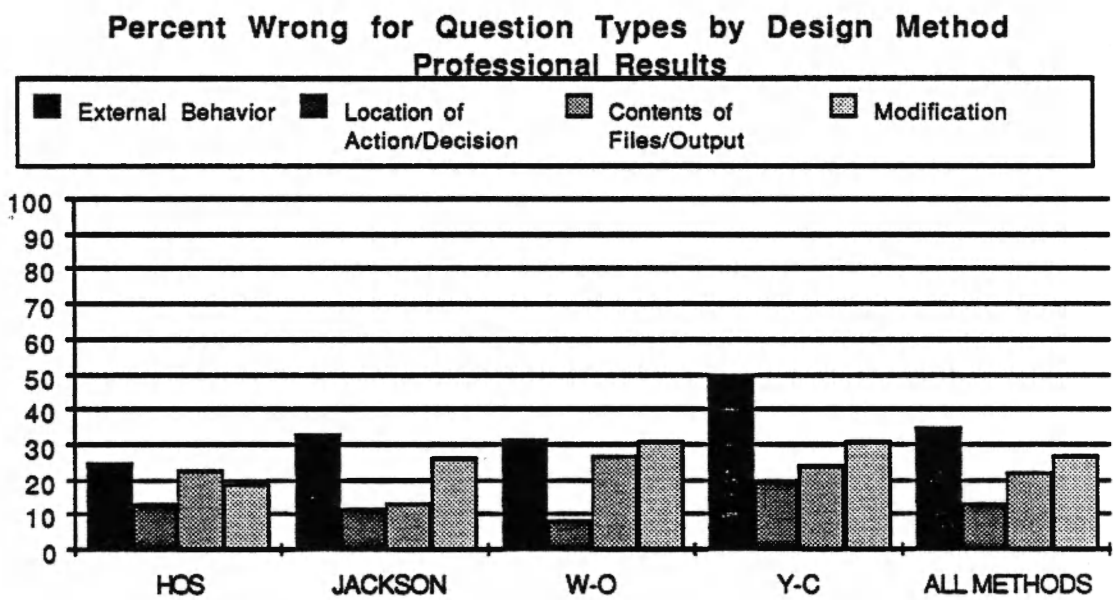


DIAGRAM 14

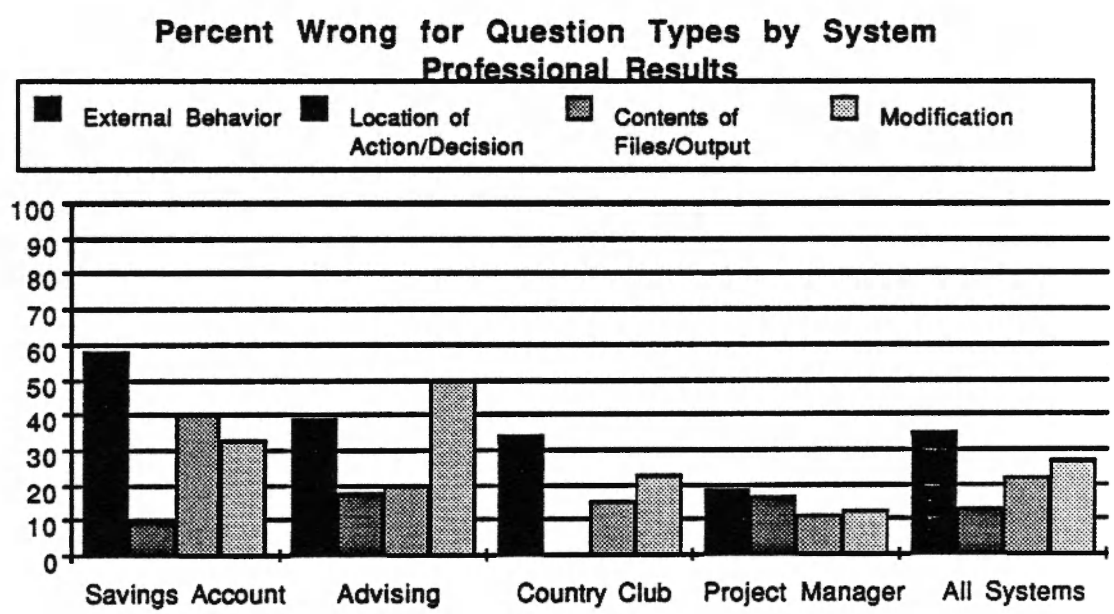


DIAGRAM 15

Savings Account within Jackson is high for external behavior as are the other systems within Jackson. Contents of files or output and modification type questions is where there is a difference between the Savings Account system and the other systems in Jackson. Particularly modification type questions, Savings Account missed fifty percent of these questions while the other three systems in Jackson were at 16.6667 percent wrong for modification type questions.

There are many similarities between the professional and student results but there are differences in which design method is best understood within the particular question types. Diagrams 16 through 18 show the student results for percent wrong for question types. The decreasing order for the question types was external behavior, modification, contents of files or output and location of action or decision.

The students only had one area in which they made assumptions, this was external behavior as seen on diagram 18. Modification and contents of file or output type questions decrease in the order that the systems were presented with the exception of savings account.

The student results by design method are different from the professional results as seen on diagram 17. The lowest percentages for external behavior and location of action or

Percent Wrong for Question Types
Student Results

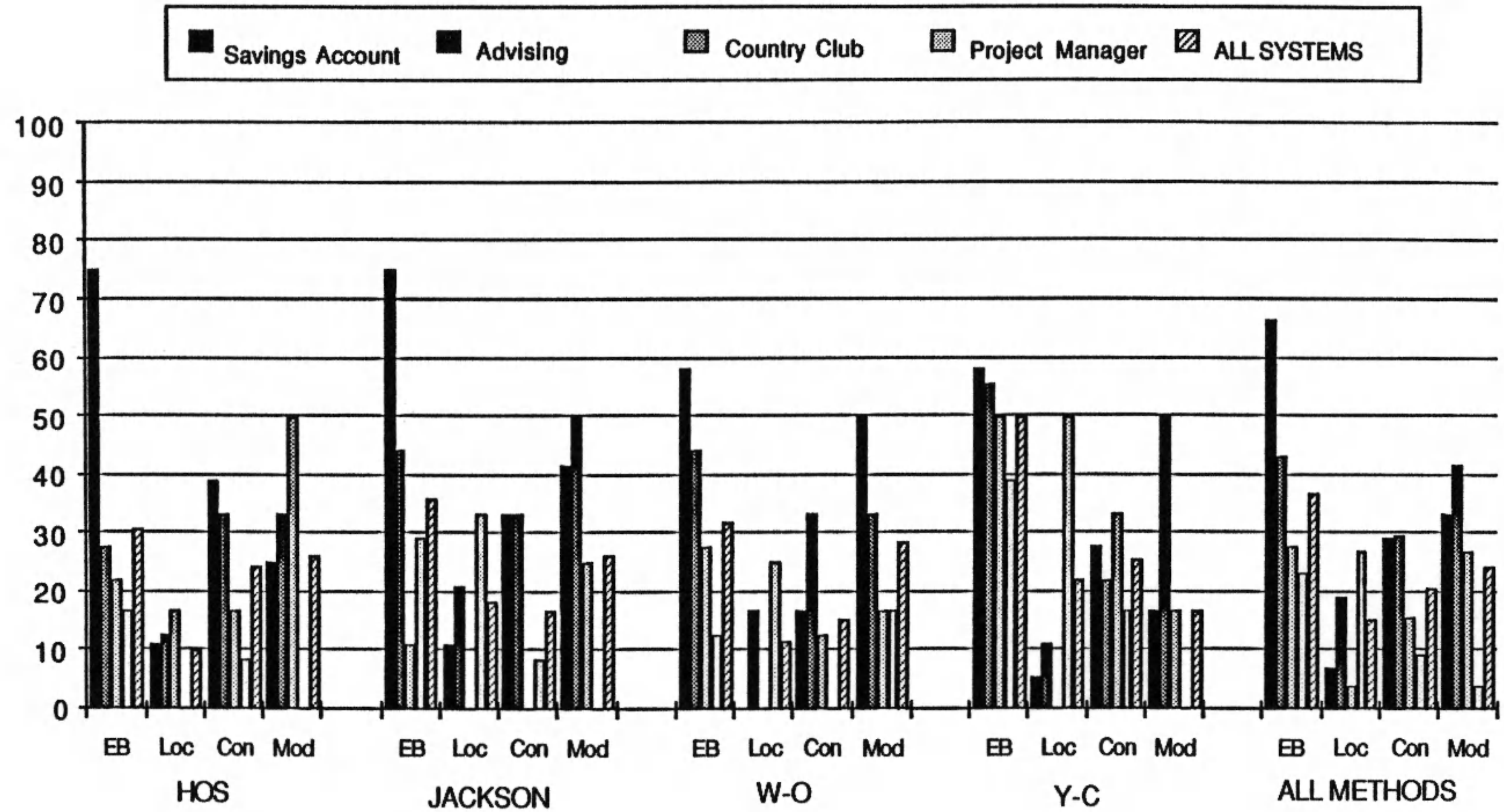


DIAGRAM 16

Percent Wrong for Question Types by Design Method
Student Results

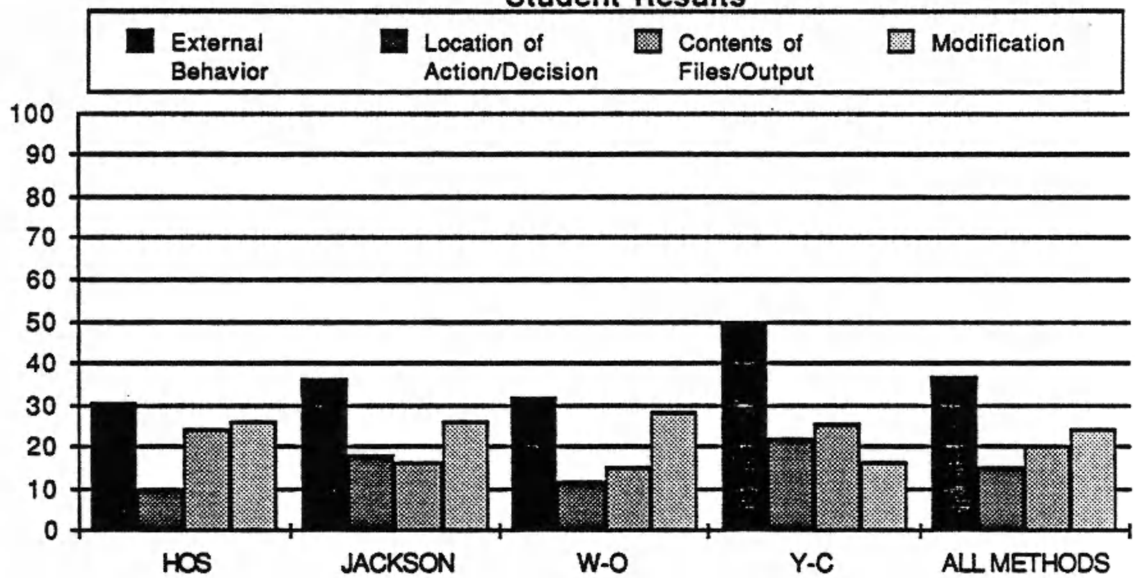


DIAGRAM 17

Percent Wrong for Question Types by System
Student Results

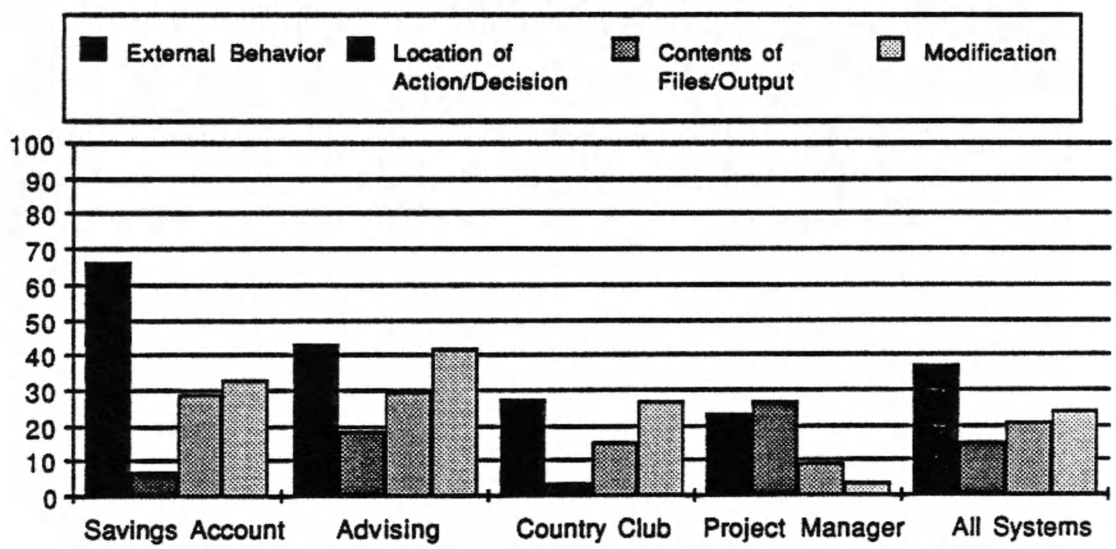


DIAGRAM 18

decision type questions is on the HOS design method. Warnier-Orr did the best on contents of files or output with the lowest percentage wrong. Surprisingly, Yourdon-Constantine did the best on modification type questions but it had the highest percentages on the other three question types.

Ratings and Selection

The rating and selection of the design methods by the subject indicates their own opinion of ease of use, but not their actual understandability. On the combined level the subjects ratings closely reflected how well they did on the diagrams. The ratings for the combined results are shown on diagram 19. The rate scale that the subjects were to select from was as follows: 1 - easy, 2 - fair, 3 - moderate, 4 - fairly difficult, and 5 - impossible. The subjects did not rate the systems in the same order as they understood them. The decreasing order for the mean ratings is Project Manager, Advising, Savings Account and Country Club. All four of the system mean ratings were between 2.48 and 2.89. The decreasing order by design method was Yourdon-Constantine, Warnier-Orr, HOS and Jackson. With the exception of HOS this is the order in which they performed on the methods. The diagram's ratings varied between 2 and 3.667. The selection of the sixteen diagrams by the forty-eight combined subject is shown in figure 2. A majority of

Mean Rate
Combined Results

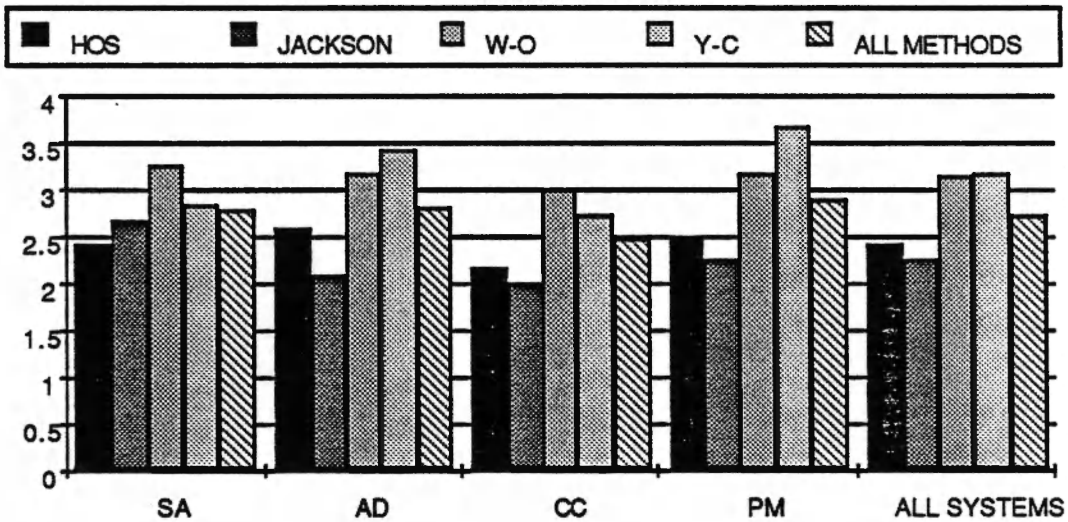


DIAGRAM 19

Times Selected	SA	AD	CC	PM	ALL SYSTEMS
HOS	4	4	4	6	18
JACKSON	3	5	7	5	20
W-O	0	1	2	3	6
Y-C	0	2	0	0	2
ALL METHODS	7	12	13	14	46

FIGURE 2

the subjects selected HOS and Jackson as the design method that they preferred. The total on the figure is forty-six because two subjects replied that they did not care for any of the design methods presented.

The professionals rated the diagrams around the moderate (3) rating and were not able to accurately reflect how well they actually understood the diagrams. The mean rates for the professional subjects are shown in diagram 20. The systems were rated in an order similar to how the subjects did on them, with the exception of the Project Manager System. The decreasing order by system was Project Manager, Savings Account, Advising and Country Club. The system ratings went from 2.625 to 3.125. The design method's ratings did not match the professional's understandability of the methods. The decreasing order in which the subject rated the design methods was Warnier-Orr, Yourdon-Constantine, HOS and Jackson. The design method ratings went from 2.458333 to 3.458333. Figure 3 shows the number of subjects who selected each diagram. Most of the professionals selected either HOS or Jackson as the preferred design method. Two of the professionals answered that they would not select any of the four design methods presented.

The students rated the diagrams between fair (2) and moderate (3), they also were not able to reflect their

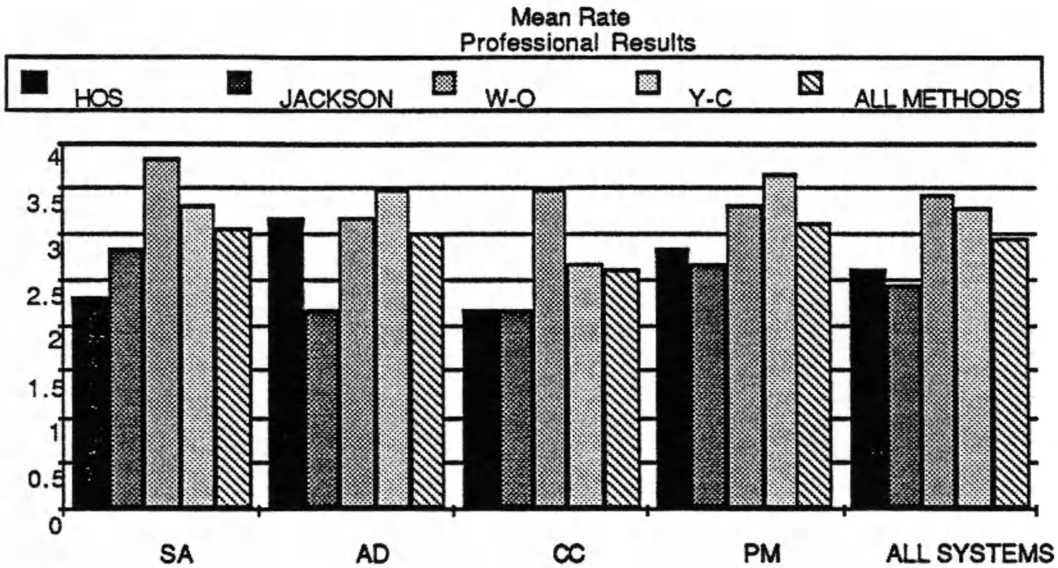


DIAGRAM 20

Times Selected	SA	AD	CC	PM	ALL SYSTEMS
HOS	3	1	3	3	10
JACKSON	2	2	5	2	11
W-O	0	0	0	0	0
Y-C	0	1	0	0	1
ALL METHODS	5	4	8	5	22

FIGURE 3

performance through the ratings. The students results of the mean ratings are given in diagram 21. The ratings for the systems did not reflect the students understandability of the systems. The order in which the rates decreased was Project Manager, Advising, Savings Account and Country Club. The system ratings went from 2.333 to 2.666. The design method's ratings also did not reflect the students understandability. The decreasing order in which they rated the design methods was Yourdon-Constantine, Warnier-Orr, HOS and Jackson. The design method ratings went from 2.041666 to 3.041666. The number of student subjects who selected each diagram is given in figure 4. The students were spread fairly even across HOS, Jackson and Warnier-Orr. The systems were not selected evenly. Although the students did not show much of a difference on the understandability of the systems, they did show quite a difference on how easy they perceived the systems to be.

Effects of Experience

Dividing the test groups into those who had seen the design methods before and those who had not seen the design methods before shows the effects of the subject's experience on the performance. The mean errors for these four groups are given in figures 5 through 8. The professionals who had seen the design methods, figure 5, did better than the professionals who had not seen the design methods, figure 6,

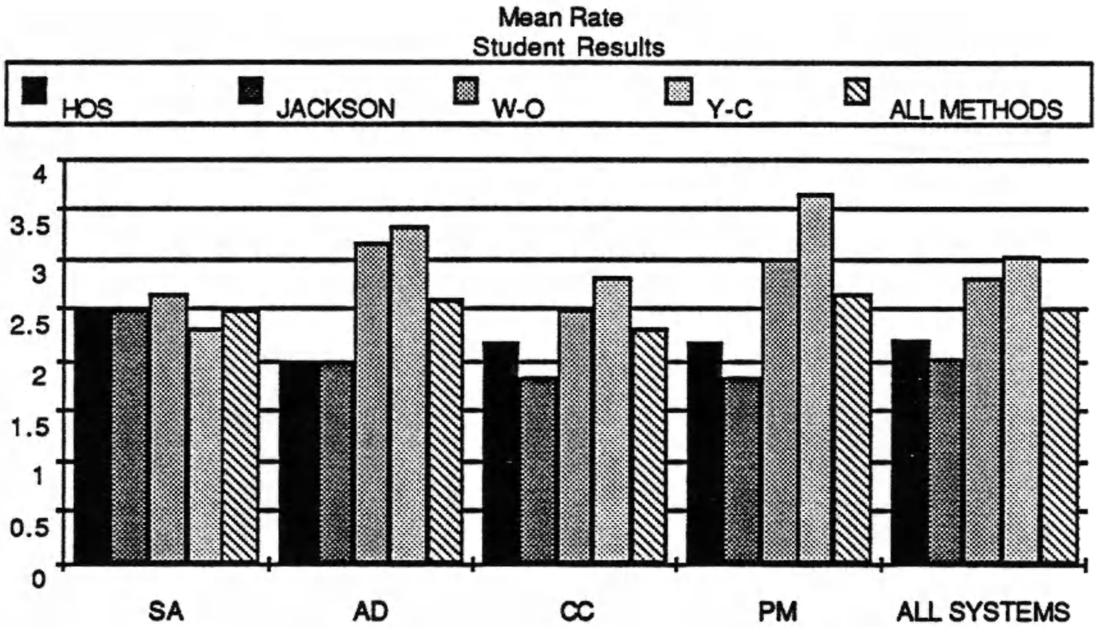


DIAGRAM 21

Times Selected	SA	AD	CC	PM	ALL SYSTEMS
HOS	1	3	1	3	8
JACKSON	1	3	2	3	9
W-O	0	1	2	3	6
Y-C	0	1	0	0	1
ALL METHODS	2	8	5	9	24

FIGURE 4

Mean Number of Errors for Professionals who HAVE seen the design methods

Mean Errors	Savings Account	Advising	Country Club	Project Manager	ALL SYSTEMS
HOS	2.166666666667	3.5	0.75	1	1.785714285714
Jackson	0	2	1.5	2	1.583333333333
Warnier-Orr	4	2.333333333333	2.4	0.6	2
Yourdon-Constantine	4.4	3.2	2.5	2.666666666667	3.4
ALL METHODS	2.866666666667	2.714285714286	1.769230769231	1.5	2.232142857143

FIGURE 5

Mean Number of Errors for Professionals who HAVE NOT seen the design methods

Mean Errors	Savings Account	Advising	Country Club	Project Manager	ALL SYSTEMS
HOS	---NA---	3.5	3	1	2.4
Jackson	4.75	1.5	2	1	2.666666666667
Warnier-Orr	4	3.333333333333	2	1	3.222222222222
Yourdon-Constantine	2	2	3	3	2.777777777778
ALL METHODS	4.111111111111	2.9	2.545454545455	1.6	2.75

FIGURE 6

Mean Number of Errors for Students who HAVE seen the design methods

Mean Errors	Savings Account	Advising	Country Club	Project Manager	ALL SYSTEMS
HOS	3	--- NA ---	0	--- NA ---	1.5
Jackson	4	2	--- NA ---	2	2.666666666667
Warnier-Orr	3	2.666666666667	0.333333333333	2.5	2
Yourdon-Constantine	--- NA ---	2.5	3.5	3	3
ALL METHODS	3.25	2.5	1.333333333333	2.5	2.3

FIGURE 7

Mean Number of Errors for Students who HAVE NOT seen the design methods

Mean Errors	Savings Account	Advising	Country Club	Project Manager	ALL SYSTEMS
HOS	3.6	2.333333333333	3	0.833333333333	2.363636363636
Jackson	3.6	3.6	0.833333333333	2	2.428571428571
Warnier-Orr	2.5	3.333333333333	3	0.75	2.285714285714
Yourdon-Constantine	2.5	4.25	3	2.6	3
ALL METHODS	3.05	3.277777777778	2.277777777778	1.55	2.526315789474

FIGURE 8

on seven of the diagrams. These diagrams were Jackson Savings Account and Country Club, Warnier-Orr Advising and Project Manager, Yourdon-Constantine Country Club and Project Manager, and HOS Country Club. Five of the diagrams had a lower mean number of errors if the professionals had not seen the design method before, Jackson Advising and Project Manager, Yourdon-Constantine Savings Account and Advising, and Warnier-Orr Country Club. Three diagrams, HOS Advising and Project Manager and Warnier-Orr Savings Account, had the same mean number of errors for both the professionals who had seen the design methods and those who had not seen them previously. All four of the system for all-methods had a lower mean number wrong if the professionals had seen the design methods before the actual test. Three of the design methods for all-systems, HOS, Jackson, and Warnier-Orr, also had lower means for the professionals who had seen them before. Yourdon-Constantine however, had a lower mean number of errors if the subjects had not seen this design method prior to the test.

The student subjects who had seen the design methods, figure 7, had lower means than the students who had not seen the design methods, figure 8, on the six following diagrams: Jackson Advising, Yourdon-Constantine Advising, HOS Savings Account and Country Club, and Warnier-Orr Advising and Country club. There were five diagrams for which the opposite was true, the subjects who had not seen the design method did better. These diagrams were Warnier-Orr Savings Account and Project Manager, Yourdon-Constantine Country Club and Project Manager, and Jackson Savings Account. Only one diagram, Jackson Project Manager, had the same mean number of errors for both subgroups of student subjects. By system for all-methods Savings Account and Project Manager had lower mean number of errors if the students had not seen the design methods previously. While by design methods, for all-systems the subjects did better on the Jackson design method if they had not seen this design method prior to the test. Yourdon-Constantine for all-systems had an equal number of errors for both students who had and had not seen this method before taking the test.

The difference between the total mean number wrong, all-methods and all-systems, for the two subdivisions of the students is a little more than two tenths of a point. While the difference in the totals for the two professional groups is almost half an point. Also there were four diagrams for which none of the students had seen the particular design method these were Jackson Country Club, Yourdon-Constantine Savings Account and HOS Advising and Project Manager. The professionals had one diagram, HOS Savings Account, on which all of them had seen the design method previous to testing.

Student vs. Professional

A comparison of students and professionals indicates some differences but many similarities in their performance. The trend for the mean times, training and questionnaire, were similar for both test groups. The professional's times were approximately forty-five seconds to over a minute faster than the student's times. The questionnaire time's ranges for the design methods were fifty-four seconds for the professionals and a minute twenty-three seconds for the students. The professional questionnaire times ranged from 7:53 for Jackson to 8:47 for HOS. The student questionnaire times ranged from 8:38 for Jackson to 10:01 for Warnier-Orr. The students had faster questionnaire times than the professionals on some of the diagrams. The students had faster questionnaire times on the following diagrams: Yourdon-Constantine Savings Account and Advising, Jackson Advising and Warnier-Orr Country Club. This result is not surprising however, because Moher and Schneider [7] proved that on short reading tasks such as this, there is not much of a performance difference between professional and student. The questionnaire times did not weigh heavily on the understandability of the design methods in this study because the times were so close together.

The professionals had a lower mean number of errors than the students on the HOS and Jackson diagrams while the students did better than the professionals on the Warnier-Orr and Yourdon-Constantine diagrams. By examining diagrams 8 and 9, we can see differences in the trends between the two test groups. Warnier-Orr varied the most for the professionals by having both the high and the low, while it was the most consistent for the students. Jackson was just the opposite, it was the most consistent for the professionals but had both the high and the low for the students. The students had a lower mean number wrong than the professionals on some of the diagrams. The diagrams on which the students performed better than the professionals are the following: Yourdon-Constantine Savings Account and Project Manager, Warnier-Orr Savings Account and Country Club, HOS Project Manager and Advising, and Jackson Country Club. These are not all of the same diagrams for which the students had faster times than the professionals. The mean number wrong by design method shows that the students looked at the methods equally while the professionals did not. The mean number of errors for the professionals had a difference, between the high and low, of more than one point. The student's range, between the high and low mean number wrong, was less than one point. The mean number wrong by system also shows that the professionals made more assumptions than the students. The professional's mean ranged from 1.5416667 for Project Manager to 3.3333333 for Savings Account, more than one and three-quarters points difference. The range of the student's mean was from 1.708333 for Project Manager to 3.083333 for both Savings Account and Advising, less than one and a half points difference.

The total percent wrong for question types were similar for both test groups. A comparison of diagrams 13 and 16 shows where the differences in the two groups lie. The highest percent wrong for the students was in HOS and Jackson while the highs for the professionals were in Yourdon-Constantine. Third high was Warnier-Orr and Yourdon-Constantine for the students while for the professional it was in Warnier-Orr. The percent wrong was spread more evenly across all four design methods for the students while the professionals have a steady rise in the order of HOS, Jackson, Warnier-Orr and Yourdon-Constantine.

The students rated the design methods nearly a half of a point easier than what the professionals rated them. The professional's overall mean rate was 2.958333 while the student's overall mean rate was 2.53125. The range between the ratings of the design method was exactly one point for both professionals and students. The range for the students went from 2.04166667 for Jackson to 3.04166667 for Yourdon-Constantine. The range for the professionals went from 2.4583333 for Jackson to 3.4583333 for Yourdon-Constantine. The student's selection of the design methods was divided fairly even among HOS, Jackson and Warnier-Orr, while the professionals selected HOS and Jackson and none selected Warnier-Orr.

- CONCLUSION -

Result 1:

The subjects interjected their own assumptions into the diagrams for which they thought they knew the system or the design method instead of actually reading the diagram. This is indicated by the trend of the systems on the questionnaire times and mean number wrong. They both decrease in the order that the systems were presented. The professional results decreased sharply. This indicates that the professionals made more assumptions than the students.

Result 2:

The subjects were able to trace the diagrams but had difficulty understanding the diagrams as a whole system. They did well on the contents of files or output and location of action or decision type questions, which required tracing of the diagram. The subjects performed badly on the external behavior and modification type questions, which required overall understandability.

Result 3:

The subjects made more assumptions about external behavior. The percent wrong for external behavior and contents of files or output type questions decreased in the same order that the systems were presented. This shows that these two areas were the types of questions in which the subjects made assumptions.

Result 4:

Through the ratings, none of the subjects were able to accurately reflect their performance on the diagrams. Neither test group's ratings matched their performance by system or by design method.

Result 5:

The students rated the diagrams as easier than the professionals rated them. This also supports result 1; in that the professionals made more assumptions making the diagrams more difficult than they actually were.

Results 6:

The design method for each test group, HOS for professionals and Warnier-Orr for students, that had the least mean number wrong also had the longest questionnaire time.

Result 7:

Yourdon-Constantine did the worst overall. For both test groups, it had the highest mean number wrong as well as the highest percent wrong for external behavior type questions. The students did best on modification type questions using Yourdon-Constantine and this method had the second fastest times. Though these times are fair, the accuracy was very bad and accuracy is a more important factor than speed.

Result 8:

Warnier-Orr had both the highest and the lowest mean number of errors for the professionals while it had the lowest overall mean number of errors for the students. It also consistently, had a low percent wrong on location of action or decision question type. The times for Warnier-Orr were always either the longest or second longest.

Result 9:

Jackson did the worst on the report type system which was what this method was designed to be used for. It did particularly bad on the modification type questions for the report type system. It had the second lowest mean number of errors for the students. Overall, however, Jackson did well on contents of files or output type questions and it had the lowest mean number of errors for the professionals. In all of the times Jackson was the fastest.

Result 10:

HOS did the best overall. It had the lowest mean number wrong for the professionals and the second lowest mean number wrong for the students. This makes HOS effective as both a design and a communication tool. HOS had the lowest percent wrong for external behavior and modification type questions. These two types of questions were the most difficult for the subjects to understand yet HOS did best in these areas. The subjects understood the systems in general terms best when it was designed using HOS but they had difficulty tracing the HOS diagrams. The possible reason for this is that HOS diagrams tend to get large quickly and the subjects may have been overwhelmed by its size. HOS always had either the longest or second longest times but as mentioned earlier accuracy is much more important than speed. Also the times for all of the design methods were so close together that they did not have much of an impact on this study.

Discussion

The conclusion of which design method is the best relies heavily on a speed/accuracy tradeoff. As mentioned earlier the accuracy of a software design should be more important than speed in doing the design. The question is how much of a tradeoff is there. In this study Jackson had the fastest times and HOS had the longest times but there was less than a minute and a half difference between the two. HOS had the lowest mean number wrong and Jackson had the second lowest mean number wrong. So which design method is best? Jackson did bad on report type systems which is what Jackson is supposed to be used for. HOS however, did the best in the two areas where the subjects had the most difficulty. This is a very important point, because the two areas were external behavior and modification. These two areas were the most important when it came to understandability, being able to trace a diagram is not of much use when the overall behavior is not understood.

The result, that the subjects made assumptions on diagrams for which they thought they knew the system or design method, shows a significant conclusion. No matter what the design method, stick to the rules for that particular design method. Also read the diagram with no biases or assumptions that could deter the understandability of that diagram.

Aside from the major points presented here. There are many other very interesting points that could be concluded. But it is the feeling of this author that in order to positively make conclusions on these other aspects further research is warranted. It is the hope that this research may show insights to areas of design understandability that need further investigation.

Further Research

As mentioned above this research indicates that further research is warranted. Some suggestions of possible research is given here. A larger test should be given. This should include larger diagrams and longer tasks as well as larger test groups. The larger diagrams may show that the difference in the design methods may be related to diagram size. Having a longer task may give a clearer picture of the speed that each design method requires. It could give wider variations between the times for each method. Finally, a larger test group will remove any extremes in the scores.

Another suggestion for modifying this test is to add to the possible answers. It could either be kept multiple choice and add a "None of the above" option, or allow the subjects to enter their own answer. The second suggestion however, would make the grading more subjective.

A final suggestion is to trace the thought process more carefully. This could be done by having the subjects vocalize what they were thinking. This could be either tape recorded or video taped. The test system could also be a more controlled test instead of allowing the subjects to take the test on their own free time.

Appendix A

System Descriptions and Questionnaires

SAVINGS ACCOUNT SYSTEM

The Savings Account System is designed to run at the end of each month. It reads in files for each savings account; does the appropriate bookkeeping for month end transactions, such as interest payments and finance charges. Then it produces a Monthly Savings Account Report to be sent to each account holder.

1. Which file contains the date and amount of a deposit?

A. Account Balance File
===> B. Transaction File
C. Daily File

2. Which is the correct form for the headings?

===> A. ACCOUNT # ----
ACTIVITY month-name
BALANCE FORWARD OF $--.--
DATE ACTION DR CR BALANCE
B. ACCOUNT # ---- ACTIVITY month-name BALANCE FORWARD OF $--.--
DATE
ACTION
DR
CR
BALANCE
C. DATE ACTION DR CR BALANCE
BALANCE FORWARD OF $--.--
ACTIVITY month-name
ACCOUNT # ----

3. Which of the following does the Monthly Savings Account Report contain?

A. Finance Charge and Interest
===> B. Finance Charge or Interest
C. Neither finance Charge nor Interest
D. Always Interest only

4. When is the balance reported?

A. After each transaction
B. At the end of the report
C. Before all transactions
===> D. All of the above

5. The bank does not want to have a finance charge for dependent's accounts, no matter how low the average balance is. What should be changed?

HOS

A. All average balance calculations should be deleted

===> B. The tests out of 'CALCULATE ADJUSTMENTS' need to be changed

C. Remove the 'PROCESS FINANCE CHARGE' module

JACKSON

A. 'CONSUME AVE. BALANCE, PRODUCE ADJUSTMENT' needs to be changed to 'PRODUCE ADJUSTMENT'

===> B. The tests out of 'CONSUME AVE. BALANCE, PRODUCE ADJUSTMENT' need to be changed

C. Remove the 'CONSUME FINANCE CHARGE, PRODUCE FINANCE LINE' module

WO

A. All average balance calculations should be deleted

===> B. The tests '?4' and '?5' need to be changed

C. Remove the 'FINANCE' module

YC

A. All average balance calculations should be deleted

===> B. The tests within 'ADJUSTMENTS CONTROLLER' need to be changed

C. Remove the 'PROCESS MONTH END' module

6. The bank wants to add a bulletin, about special services they have to offer, at the bottom of the report. Where would you add this to the system?

HOS

A. Add the module to the right of 'PROCESS TOTALS' and below 'PRODUCE MONTHLY SAVINGS ACCOUNT REPORT'

===> B. Add the module to the left of 'PROCESS TOTALS' and below 'PRODUCE MONTHLY SAVINGS ACCOUNT REPORT'

C. Add the module below 'PROCESS TOTALS'

JACKSON

A. Add the module to the left of 'PRODUCE TOTAL LINE' and below 'PRODUCE MONTHLY SAVINGS ACCOUNT REPORT'

===> B. Add the module to the right 'PRODUCE TOTAL LINE' and below 'PRODUCE MONTHLY SAVINGS ACCOUNT REPORT'

C. Add the module below 'PRODUCE TOTAL LINE'

WO

A. Add to the 'TOTALS' module

===> B. Add a module between the 'TOTALS' and '.END' modules

C. Add to the '.END' module

YC

===> A. Add the module to the right of 'FORMAT TOTALS'
B. Add the module to the left of 'GET ACCOUNT BALANCE FILE & TRANSACTON FILE'
C. Add the module below 'FORMAT TOTALS'

7. When is it decided if there is a finance charge or if interest should be paid?

A. After each transaction
B. After the totals are printed
===> C. After all of the transactions

8. What is done after a deposit is reported?

A. The totals are reported
===> B. Checks if there are any more transactions to process
C. Withdrawals are processed
D. Interest is calculated and reported

9. When is the average balance calculated?

HOS, JACKSON, WO

A. After the totals are printed
===> B. After all transactions are reported and before totals are reported
C. Immediately after the headings are printed

YC

A. Within 'TRANSACTION CONTROLLER'
===> B. Within 'ADJUSTMENT CONTROLLER'
C. Within 'PROCESS MONTH END'

10. What module prints the account number of the customer that the report is being printed for?

HOS

A. PROCESS TOTALS
B. PROCESS MONTH END CALCULATIONS
===> C. PROCESS HEADINGS

JACKSON

A. PRODUCE TOTAL LINE
B. PRODUCE ADJUSTMENT
===> C. PRODUCE HEADING

WO

A. TOTALS
B. ADJUSTMENTS
===> C. HEADING

YC

A. FORMAT TOTALS
B. PROCESS MONTH END
===> C. FORMAT HEADINGS

ADVISING SYSTEM

This system is designed to aid in advising a student of a classes they should take. The file it accesses are an Arts & Sciences requirements file, a core requirements file, a suggested four year progression file and a technical elective options file. There are also files on what the student is taking or has taken, these include an Arts & Sciences courses file, Core courses file and technical electives file. The student can make various additions, deletions, and changes to their own files. They can also print out various reports using their own file or the system files.

1. What is displayed after an Arts & Sciences course is deleted?

HOS, JACKSON, WO

A. Advising menu
B. Maintain menu
===> C. Update menu

YC

A. Advising menu
B. Maintain menu
===> C. A&S menu

2. What is displayed after the printflag is set to false?

A. Report menu
===> B. Advising menu
C. Maintain menu

3. Which report contains the core courses that the student is taking or has taken?

A. FOUR YEAR PROGRESSION REPORT
===> B. STUDENT CORE REPORT
C. CORE REPORT

4. Which reports would be the same for all students?

===> A. FOUR YEAR PROGRESSION REPORT, CORE REPORT, TECH ELECT REPORT
B. STUDENT TECH ELECT REPORT, STUDENT CORE REPORT, STUDENT A&S REPORT
C. FOUR YEAR PROGRESSION REPORT, STUDENT CORE REPORT, STUDENT A&S REPORT

5. After a report is printed to the printer, what is displayed?

A. Advising menu
===> B. Report menu
C. Maintain menu

6. What module would you select, from the Advising menu module, if you wanted to delete an A&S course that you have since dropped?

HOS

===> A. MAINTAIN STUDENT INFORMATION

B. OBTAIN STUDENT INFORMATION

C. GENERAL REPORTS

JACKSON

===> A. CONSUME STUDENT FILE, MAINTAIN STUDENT INFORMATION

B. CREATE STUDENT FILE

C. GENERAL REPORTS

WO

===> A. MAINTAIN STUDENT INFORMATION CHOICE

B. OBTAIN STUDENT INFORMATION CHOICE

C. GENERAL REPORTS CHOICE

YC

===> A. MAINTAIN STUDENT INFORMATION

B. GET STUDENT INFORMATION, CREATE FILES

C. GENERAL REPORTS

7. Which module initially sets up the students files, by creating them?

HOS

A. UPDATE A&S

B. UPDATE CORE

===> C. OBTAIN STUDENT INFORMATION

JACKSON

A. CONSUME A&S RECORD, UPDATE A&S

B. CONSUME CORE RECORD, UPDATE CORE

===> C. CREATE STUDENT FILE

WO

A. UPDATE A&S CHOICE

B. UPDATE CORE CHOICE

===> C. OBTAIN STUDENT INFORMATION CHOICE

YC

A. UPDATE A&S

B. UPDATE CORE

===> C. GET STUDENT INFORMATION

8. The school wants to add a module that will compare courses that have already been taken, A&S, core and tech. elect., with the four year progression file. From this comparison the module will give 'advice' as to which courses should be taken the following semester. On which menu should the option be placed to select such a module?

A. Maintain menu
B. Report menu
===> C. Advising menu

9. Which module determines if a report is to be output or not?

HOS, WO
A. PROCESS MAINTAIN MENU CHOICE
===> B. CHECK PRINT FLAG
C. REPORT MENU

JACKSON
A. DISPLAY MAINTAIN MENU, PROCESS CHOICE
===> B. CHECK PRINT FLAG
C. DISPLAY REPORT MENU, PROCESS CHOICE

YC
A. MAINTAIN CONTROLLER
===> B. FORMAT REPORT
C. REPORT CONTROLLER

10. If you were changing some technical elective courses and wanted to quit what item(s) would you select from which menu(s)?

HOS
===> A. Select 'MAINTAIN STUDENT INFORMATION' from the 'UPDATE TECH ELECT MENU', Select 'ADVISING' from the 'MAINTAIN MENU', and Select 'EXIT PROGRAM' from the 'ADVISING MENU'
B. Select 'EXIT PROGRAM' from the 'ADVISING MENU'
C. Select 'PRINTFLAG = FALSE' from the 'REPORT MENU', Select 'EXIT PROGRAM' from the 'ADVISING MENU'

JACKSON

===> A. Select 'RETURN TO MAINTAIN MENU' from the 'UPDATE TECH ELECT MENU', Select 'RETURN TO ADVISING' from the 'MAINTAIN MENU', and Select 'EXIT PROGRAM' from the 'ADVISING MENU'

B. Select 'EXIT PROGRAM' from the 'ADVISING MENU'

C. Select 'PRINTFLAG = FALSE' from the 'REPORT MENU', Select 'EXIT PROGRAM' from the 'ADVISING MENU'

WO

===> A. Select 'SET END OF UPDATE TO TRUE' from the 'UPDATE MENU', Select 'EXIT MAINTAIN CHOICE' from the 'MAINTAIN MENU', and Select 'EXIT PROGRAM CHOICE' from the 'ADVISING MENU'

B. Select 'EXIT PROGRAM CHOICE' from the 'ADVISING MENU'

C. Select 'EXIT REPORT CHOICE' from the 'REPORT MENU', Select 'EXIT PROGRAM CHOICE' from the 'ADVISING MENU'

YC

10. What data items does MAINTAIN CONTROLLER use?

===> A. STUDENT A&S, STUDENT CORE, and STUDENT TECH ELECT

B. STUDENT A&S, STUDENT CORE, STUDENT TECH ELECT and CHOICE

C. STUDENT A&S, STUDENT CORE, STUDENT TECH ELECT and SYSTEM FILES

COUNTRY CLUB SYSTEM

This Country Club System is designed to maintain the member's file. This includes adding transactions to a member's record, adding, changing and deleting a member's record. Other items this system does, but are not detailed on this diagram, are produce billing statements, list members, and produce a sales report.

1. What is displayed after a member's record is deleted?

===> A. Update Menu
B. Delete prompt
C. Modify Menu

2. If you are beginning to add a transaction, what is displayed after an invalid name is entered?

A. Update Menu
===> B. Main Menu
C. Modify Menu

3. What is the basic information in a new member's record?

A. Name, Account Number, and Office Phone
===> B. Name, Account Number, Address and Phone
C. Name, Account Number, and Occupation

4. What information must be entered for adding a transaction?

A. Amount, Code, Date, and Type
B. Account Number, Name and Amount
===> C. Account Number, Name, Type, Date, Code, and Amount

5. If a member no longer had a phone number which module would you enter to update this member's record?

HOS, YC
A. 'DELETE MEMBER RECORD'
B. 'ADD MEMBER RECORD'
===> C. 'MODIFY MEMBER RECORD'

JACKSON
A. 'CONSUME ACCOUNT NUMBER, PROCESS ACCOUNT'
B. 'ADD MEMBER RECORD'
===> C. 'MODIFY MEMBER RECORD'

WO
A. 'CONSUME ACCOUNT NUMBER, PROCESS ACCOUNT'
B. 'ADD MEMBER RECORD'
===> C. 'MODIFY MEMBER RECORD CHOICE'

6. What must be entered before a member's record can be modified?

===> A. Account number only
B. Member name only
C. Account number and member name

7. When a new member is added to the system, where does the account number come from?

A. Whoever is entering the record makes it up
===> B. The system generates it
C. The member's phone number is entered as their account number

8. The country club wants to modify the system so that a member, who's account is delinquent can not perform a transaction until their bill has been paid. Where would you add this module?

HOS, JACKSON, WO
===> A. Add another level after the member's name has been validated
B. Add another level after 'UPDATE TRANSACTION' has been selected
C. After everything else for a transaction has been entered

YC
===> A. After the member's name has been validated
B. After 'UPDATE TRANSACTION' has been selected
C. After everything else for a transaction has been entered

9. The country club wants their Vice President in charge of membership to be the only person who can delete a member's record. They have decided to have the security be a password that only he knows. Where would you place the prompt and test for the password?

A. After the member's account number is entered before the delete prompt
===> B. After delete has been selected from 'UPDATE MENU'
C. Before the 'UPDATE MENU' is displayed

10. A member has three transactions, in entering those how many times would you see the main menu?

A. Three
B. Two
===> C. One

PROJECT MANAGER SYSTEM

The Project Manager System is designed to allow the manager of a project team to enter components [tasks] of a project and then see various management reports. The components contain an id, keyword and data. They can be added, deleted or changed in an editor. The system then runs a trace of the project and if it traces, the manager can select several management report to be printed.

1. What is displayed after a component is deleted?

A. ´MAIN MENU´
B. ´OUTPUT MENU´
===> C. ´EDITOR MENU´

2. What is displayed after a trace fails?

===> A. An error message
B. ´OUTPUT MENU´
C. ´MAIN MENU´

3. What module allows you to see the components in a component file?

HOS, WO
A. ´PRODUCE OUTPUTS´
B. ´ADD COMPONENT´
===> C. ´PROCESS EDITOR MENU CHOICE´

JACKSON
A. ´PRODUCE OUTPUTS´
B. ´ADD COMPONENT´
===> C. ´DISPLAY EDITOR MENU, PROCESS CHOICE´

YC
A. ´PRODUCE OUTPUTS´
B. ´ADD COMPONENT´
===> C. ´EDITOR CONTROLLER´

4. What does a component consist of?

A. A keyword
===> B. An id, keyword and data
C. An id and data

5. After entering the editor, what is in the ´TEMP FILE´?

===> A. The component file to be edited
B. The trace of a component file
C. The keywords from the component file to be edited

6. What is displayed after a report is printed?

HOS, JACKSON, WO
A. 'MAIN MENU'
===> B. 'OUTPUT MENU'
C. 'EDITOR MENU'

YC
A. 'MAIN MENU'
===> B. 'REPORT MENU'
C. 'EDITOR MENU'

7. Where would you add a module which would save the comp file under a different name?

HOS, JACKSON, WO
===> A. As another option on the editor menu
B. As another option on the main menu
C. As another option on the output menu

YC
===> A. As another option on the editor menu
B. As another option on the main menu
C. As another option on the report menu

8. Where would you add a module which would reassign an existing id to an existing keyword and data?

HOS, JACKSON, WO
===> A. As another option on the editor menu
B. As another option on the main menu
C. As another option on the output menu

YC
===> A. As another option on the editor menu
B. As another option on the main menu
C. As another option on the report menu

9. On the editor menu, what is the difference between the quit and abort options?

A. Quit does NOT save the edited changes, abort does
===> B. Quit does save the edited changes, abort does NOT
C. There are no differences

10. Which modules are repeated until the exit from the module is chosen?

HOS

A. PROCESS TRACE, TRACE COMP FILE and EDIT COMP FILE

B. EDIT VALID COMP FILE and TRACE VALID COMP FILE

===> C. PROJECT MANAGER SYSTEM, COMPONENT EDITOR, EDIT TEMP FILE, and PRODUCE OUTPUTS

JACKSON

A. PROCESS TRACE, COMPONENT EDITOR and EXIT PROGRAM

B. PROCESS VALID COMP FILE and PERFORM TRACE, PROCESS RETURN CODE

===> C. DISPLAY MAIN MENU, DISPLAY EDITOR MENU, DISPLAY NAME PROMPT, and DISPLAY OUTPUT MENU

WO

A. PROCESS TRACE, PROCESS COMP FILE NAME and EDIT COMP FILE

B. EDIT VALID COMP FILE and TRACE VALID COMP FILE

===> C. PROJECT MANAGER, EDITOR, EDIT TEMP FILE, and PRODUCE OUTPUTS

YC

10. What data elements are used by the editor controller?

A. COMP FILE and CHOICE

B. TEMP FILE and CHOICE

===> C. COMP FILE, TEMP FILE and CHOICE

Appendix B

Design Method Descriptions and Training Questions

Higher Order Software Design Method

This is an Higher Order Software [HOS] diagram. It is a decomposition tree, that is, a tree of boxes where each box can be decomposed or divided into more sub-boxes. There are two possible types of decomposition: composition and partition. Composition is an 'and' function. All of the sub-boxes are performed. They are executed from right to left. Partition is an 'or' function. This is indicated by conditions associated with arcs coming out of the decomposed box. The conditions are shown in brackets {}. Only the one box for which the condition holds true is executed.

A module refers to either a single box or a group of boxes. If a single box is referred to as a module it should be on the lowest level i.e. no other boxes below it. In this diagram 'DISPLAY BOARD' could be called a module. If a group of boxes is referred to as a module, the box on the highest level of the group is referenced, the module then includes that box and non-module sub-boxes. When 'CONTINUE PLAY' is referred to as a module it includes 'SWITCH PLAYER AND OPP' and 'PLAY'.

In order for an HOS diagram to show iteration, a recursive call to a module at a higher level is performed. For example, this is used to allow players to take turns. After the first player has moved and captured, the module 'CONTINUE PLAY' is executed. Within this module there is a recursive call to 'PLAY'. To trace this you would move up the tree to the box labeled 'PLAY' and start back down the tree with the new player and opp.

1. What happens after it is discovered that the current player 'CAN'T MOVE'?

   A. The OPP moves
   B. The OPP wins
   C. The PLAYER must try to move again

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is A. After 'CAN'T MOVE' is displayed the variable 'CAN'T.MOVE' is incremented, the 'PLAYER' and 'OPP' are switched and then a recursive call to 'PLAY'. Again, to trace this you would move back up the tree to the box labeled 'PLAY' then start back down from here. If the variable 'CAN'T.MOVE' is equal to two at this point the game would be over, but with the information given it can't be assumed the OPP would win.

2. Which modules are performed as part of 'PROCESS SEARCH RESULTS'?

   A. 'PROCESS NO POSSIBLE MOVE' then 'PROCESS POSSIBLE MOVE'
   B. 'PROCESS POSSIBLE MOVE' then 'PROCESS NO POSSIBLE MOVE'
   C. Either 'PROCESS NO POSSIBLE MOVE' or 'PROCESS POSSIBLE MOVE'

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is C. The module 'PROCESS SEARCH RESULTS' is decomposed conditionally. This means that only ONE of the sub-modules are performed. The one that is performed is the module with the true condition.

3. Which module are performed as part of 'GAME OVER'?

   A. 'OTHELLO' then 'DISPLAY WINNER'
   B. 'DISPLAY WINNER' then 'OTHELLO'
   C. 'OTHELLO', 'PLAY' and 'DISPLAY WINNER'

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is B. The module 'GAME OVER' is an 'and' decomposition. This means that the sub-modules are performed from right to left. It first executes 'DISPLAY WINNER' and then it performs a recursive call to 'OTHELLO'.

4. Where would you add a module that would allow a player to ask for the computer's advice on where he should move next?

   A. Add the module as another conditional out of 'PROCESS MOVE POSITION'
   B. Add the module below 'SETUP'
   C. Add the module as a prompt out of 'GAME OVER'

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is A. You wouldn't want B because this would limit the player to asking for advice at the beginning of the game only. Similarly with C, the player could only ask at the end of a game. A, would allow the user to ask for advice before they moved.

Jackson Design Method

This is a Jackson diagram. It is based on the structure of the inputs and the structure of the outputs. Each are described in terms of a series of boxes. The structures are then combined to form the software structure of the whole system. There are three possible types of structures within a Jackson diagram: sequence, condition and repetition. A sequence is a box that contains no special symbol and has more than one box below it i.e. a sequence of boxes are executed. This sequence of boxes is performed from left to right. 'SETUP' is an example of a sequence structure.

A condition structure is designated by the 'O' symbol in the upper right corner of the box. The box is executed based on some condition. This can also be called a selection. One of the sub-trees is selected based on some condition. 'MOVE' and 'GAME OVER' is a condition structure. One, of these two, is selected based on some condition.

A repetition structure is designated by the '*' symbol. This indicates iteration, the sub-tree below this box will be performed multiple times. 'PLAY' is an example of an repetition structure. After the sub-tree below it is executed, you would return to 'PLAY' and execute the sub-tree again. This looping is continued until the end of some iteration condition.

A structure may also be referred to as a module.

1. Which module or structure actually shows the move and the capture?

   A. 'SETUP'
   B. 'PROCESS LEGAL MOVE'
   C. 'GAME OVER'

   HIT RETURN WHEN READY FOR AN EXPLANATION

   The correct answer is B. Within the condition structure the boxes 'PLACE PLAYER...' and 'FLIP OPP[S]' are executed. These show the move and capture, respectively.

2. What modules are performed during the execution of 'PROCESS MOVE POSITION'?

   A. 'PROCESS LEGAL MOVE' then 'PROCESS ILLEGAL MOVE'
   B. 'PROCESS ILLEGAL MOVE' then 'PROCESS LEGAL MOVE'
   C. Either 'PROCESS LEGAL MOVE' or 'PROCESS ILLEGAL MOVE'

   HIT RETURN WHEN READY FOR AN EXPLANATION

   The correct answer is C. 'PROCESS LEGAL MOVE' and 'PROCESS ILLEGAL MOVE' is a conditional structure, which means that only ONE of the two are selected based on some condition. The condition is probably whether it was a legal move or not.

3. Which structure is executed after a game is over?

   A. 'OTHELLO'
   B. 'PLAY'
   C. none

   HIT RETURN WHEN READY FOR AN EXPLANATION

   The correct answer is A. After one game is over and 'GAME OVER' is executed you would move up the tree to check for iterations. There is an iteration at 'PLAY' and then 'OTHELLO'. Since the game is over you would assume that a new game would be started, therefore a second iteration of 'OTHELLO' would be assumed.

4. Where would you add a module that would allow a players to choose who 'PLAYS' first, DARK or LIGHT?

   A. Below the module 'MOVE'
   B. Below the module 'SETUP'
   C. Below the module 'GAME OVER'

   HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is B. Because you would want to choose before a game begins. More specifically, before 'PLAYER' and 'OPP' are assigned DARK and LIGHT the first time.

Warnier-Orr Design Method

This is a Warnier-Orr diagram. The structure is described using brace notation. Each brace has a name that labels the brace. The name appears to the left of the brace. To the right of the brace is a list of entries that comprise the body of that brace into its parts. Each entry [part] can be further expanded into another brace. The brace can be interpreted as a call to the body of the brace. A brace can also be referred to as a module.

A notation below a brace name or entry indicates the number of times that the particular brace or entry will be performed. This notation can indicate repetition by '[1,n]?1', which means that it is executed 1 to n times. The '?1' is a footnote reference which gives the condition that ends the repetition. The module 'PLAY' has the notation '[1,p]?1' which means that the body of 'PLAY' will be executed many time. If you look up the footnote '?1', you can see that 'PLAY' will stop looping when 'END OF PLAY IS TRUE'.

An exclusive or relationship is indicated by two notations. First, there will be a notation under each name or entry, that is to be ORed. This will be in the form of '[0,1]?2', it will be executed 0 or 1 times based on the condition referenced by '?2'. Second, there will be a '[+]' symbol between the names or entries that are to be ORed. In this diagram, 'MOVE' and 'GAME OVER' are examples of an exclusive or relationship. One or the other of these two modules will be executed based on the conditions '?2' and '?3'.

If an exclusive or relationship is not represented then and and relationship is assumed. These names or entries are executed from top to bottom.

1. Which module would you return to after a legal move is processed?

    A. 'PROCESS LEGAL MOVE'
    B. 'MOVE'
    C. 'PLAY'

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is C. After to last statement in the body of 'PROCESS LEGAL MOVE' is executed you would move back out of the brackets until an iteration, that has not completed, is encountered. In this case 'PLAY' is the first iteration encountered. Since 'END OF PLAY' is still set to false you would again execute its body.

2. Which modules are performed during the execution of 'PROCESS WINNER'?

    A. 'DISPLAY PLAYER 'WINS'', 'DISPLAY 'TIE'' and 'DISPLAY OPP 'WINS''
    B. Either 'DISPLAY PLAYER 'WINS'' or 'DISPLAY 'TIE'' or 'DISPLAY OPP 'WINS''
    C. 'DISPLAY 'TIE''

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is B. The three entries 'DISPLAY PLAYER 'WINS'', 'DISPLAY 'TIE'', 'DISPLAY OPP 'WINS'' all have an exclusive or relationship. This means, that based on their conditions [?6, ?7, ?8] only ONE of them is executed.

3. Where are the variables PLAYER, OPP, PLAYER.CNT, OPP.CNT and CAN'T.MOVE initialized?

    A. 'SETUP'
    B. 'SETUP' and 'PROCESS LEGAL MOVE'
    C. 'SETUP' and 'PROCESS MOVE POSITION'

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is A. 'Initialized' is the first time that a variable is given a value. For these variables this is done in the module 'SETUP'.

4. Where would you add a module that would allow a player to quit in the middle of a game?

   A. Add the another exclusive or module in the body of 'PROCESS MOVE POSITION'
   B. Add the module in the body of 'SETUP'
   C. Add the module in the body of 'GAME OVER'

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is A. If it were in 'PLAY' or 'GAME OVER' then the player could only quit at the beginning or end of a game. To allow each player a chance to quit before they move you would place the module in 'PROCESS MOVE POSITION'.

Yourdon-Constantine Design Method

This is a Yourdon-Constantine diagram. It is produced from a data flow diagram. The resulting system represents the flow of the data through the system. Data is indicated on the arcs, between the boxes, with an arrow showing the direction of flow.

The top box is called ´MAIN´. There are possibly three sections below the main, these are: afferent, efferent and transform sections. They can be thought of as input, output and processing, respectively. Each can be represented as one box or many boxes.

The leftmost section is the afferent. These boxes can usually be identified by the term "GET". There is often one box for each major input. Users can be indicated by a box with a slash in the bottom right corner. A users box means that interaction with the user occurs here.

The middle section is the transform. These boxes perform the main action or processing within the system. One type of transform module can be identified by the term ´CONTROLLER´. Based on some data, it controls or selects which ONE of the sub-modules should be performed.

The rightmost section, if it exists, is the efferent. These boxes can usually be identified by the term ´PUT´. There is often one box for each major output. Again, user boxes can be indicated here.

The three sections of afferent, transform and efferent can be continued recursively down the tree. That is, a transform module can have below it an afferent, transform and efferent section. An afferent module below any module can be grouped with the afferent on the far left.

1. Where is it decided if the current game is over or not?

   A. GAME OVER CONTROLLER
   B. GAME CONTROLLER
   C. PLAY

   HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is B. The decision needs to be made before control is given to either PLAY or GAME OVER CONTROLLER. Once the decision is made that the game is over then GAME OVER CONTROLLER does receive control.

2. Where does the turn change players?

   A. SET UP
   B. PLAY
   C. PROCESS LEGAL MOVES

   HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is C. Of the three possible answers it would be the correct one. PROCESS NO POSSIBLE MOVES also switches the player and opp. SETUP initialize them the first time but PROCESS LEGAL MOVE switches them after every move.

3. What data items does GAME CONTROLLER use to 'control' the game?

   A. PLAYER and OPP
   B. PLAYER.CNT, OPP.CNT and CAN'T.MOVE
   C. BOARD

   HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is B. GAME CONTROLLER checks to see if the counts add up to the number of possible positions. It also checks to see if both can't move.

4. Where would you add a prompt and decision that would ask a player if he wanted to play or not?

   A. POSITION CONTROLLER
   B. SETUP
   C. GAME OVER

HIT RETURN WHEN READY FOR AN EXPLANATION

The correct answer is B. If it were in GAME OVER then the player could only choose not to play after he already played a game. Instead, it would be better to prompt first and then play.

Appendix C

Example Shell Programs

This appendix is examples of the test system shell programs. All of the shell programs are not presented here. The example programs included are intro, hos.tr and hos.ad. Intrc starts the system and coordinates the order that the particular subject goes through the design methods. Hos.tr is the training session for the HOS design method. The shell commands in the training programs are the same only the particular descriptions and questions vary from program to program. Hos.ad is the test program for the HOS design of the Advising System. Again, the shell commands in the test programs do not vary only the particular questions change. All of the questions and descriptions are given in Appendices A and B. Following is a list of all of the test system shell programs.

Test System Shell Programs

intro

Training Programs

hos.tr
jack.tr
wo.tr
yc.tr

Test Programs

hos.sa
hos.ad
hos.cc
hos.pm
jack.sa
jack.ad
jack.cc
jack.pm
wo.sa
wo.ad
wo.cc
wo.pm
yc.sa
yc.ad
yc.cc
yc.pm

```
intro

cd /usrb/daniels
echo "



                    WELCOME TO

       NOVICE PROGRAMMER UNDERSTANDABILITY

        OF SOFTWARE DESIGN METHODOLOGIES

                 RESEARCH PROJECT






       PLEASE ENTER YOUR SUBJECT NUMBER
       the number on the top of your packet
"
ok=no
while test $ok = no
do
  read subnum
  case $subnum in
  1 ) ok=yes
      first=hos
      second=jack
      third=wo
      fourth=yc;;
  2 ) ok=yes
      first=hos
      second=jack
      third=yc
      fourth=wo;;
  3 ) ok=yes
      first=hos
      second=wo
      third=jack
      fourth=yc;;
  4 ) ok=yes
      first=hos
```

```
     second=wo
     third=yc
     fourth=jack;;
5 )  ok=yes
     first=hos
     second=yc
     third=jack
     fourth=wo;;
6 )  ok=yes
     first=hos
     second=yc
     third=wo
     fourth=jack;;
7 )  ok=yes
     first=jack
     second=hos
     third=wo
     fourth=yc;;
8 )  ok=yes
     first=jack
     second=hos
     third=yc
     fourth=wo;;
9 )  ok=yes
     first=jack
     second=wo
     third=hos
     fourth=yc;;
10 ) ok=yes
     first=jack
     second=wo
     third=yc
     fourth=hos;;
11 ) ok=yes
     first=jack
     second=yc
     third=hos
     fourth=wo;;
12 ) ok=yes
     first=jack
     second=yc
     third=wo
     fourth=hos;;
13 ) ok=yes
     first=wo
     second=hos
     third=jack
     fourth=yc;;
14 ) ok=yes
     first=wo
     second=hos
     third=yc
```

```
    fourth=jack;;
15 ) ok=yes
    first=wo
    second=jack
    third=hos
    fourth=yc;;
16 ) ok=yes
    first=wo
    second=jack
    third=yc
    fourth=hos;;
17 ) ok=yes
    first=wo
    second=yc
    third=hos
    fourth=jack;;
18 ) ok=yes
    first=wo
    second=yc
    third=jack
    fourth=hos;;
19 ) ok=yes
    first=yc
    second=hos
    third=jack
    fourth=wo;;
20 ) ok=yes
    first=yc
    second=hos
    third=wo
    fourth=jack;;
21 ) ok=yes
    first=yc
    second=jack
    third=hos
    fourth=wo;;
22 ) ok=yes
    first=yc
    second=jack
    third=wo
    fourth=hos;;
23 ) ok=yes
    first=yc
    second=wo
    third=hos
    fourth=jack;;
24 ) ok=yes
    first=yc
    second=wo
    third=jack
    fourth=hos;;
* ) ok=no
```

```
	echo "That is an incorrect subject number
		PLEASE enter then number on your packet";;
esac
done
echo "SUBJECT NUMBER"  $subnum >> out/${subnum}.out


echo "
     In this experiment you will be given four different designs and
questionaires.  You are to use the design to answer the accompanying
questions.  We are testing how easily you understand the designs.
Each question will be timed and graded, so that we are looking at
speed and accuracy of each answer.  Once you enter an answer you will
not be given a chance to change.  Be sure that you have typed the
answer you want before you hit return.  If you type a wrong letter you
can correct it, before you hit return, by backspacing and retyping the
answer you want.  Before each design, you will be given an example
design with an explanation of that type of design and some sample
questions.  You will not answer the sample questions, instead the
correct answer will be explained to you.  On the actual questionaires
an explanation will not be given.  Please follow the instructions
carefully so that our data will be as accurate as possible.

PLEASE HIT RETURN WHEN YOU ARE READY TO BEGIN




"
read temp


echo "
First, we would like to get some information about your background.

Please enter your name"
read name
echo "NAME" $name >> out/${subnum}.out
echo "USER" $user >> out/${subnum}.out

echo "Have you ever seen or used an HOS diagram? (y/n)"
read hos
echo "SEEN HOS" $hos >> out/${subnum}.out

echo "Have you ever seen or used a JACKSON diagram? (y/n)"
read jack
echo "SEEN JACK" $jack >> out/${subnum}.out

echo "Have you ever seen or used a WARNIER-ORR diagram? (y/n)"
read wo
echo "SEEN WO" $wo >> out/${subnum}.out
```

```
echo "
Have you ever seen or used a YOURDON-CONSTANTINE diagram? (y/n)"
read yc
echo "SEEN YC" $yc >> out/${subnum}.out


echo "What computer science courses are you currently taking?

      PLEASE type the word 'END', on a line by itself, when
      you have finished entering your classes"
echo "COURSES TAKING" >> out/${subnum}.out
read class
while test ($class!=END)-o($class!=End)-o($class!=end)
do
 echo $class >> out/${subnum}.out
 read class
done

echo "PLEASE EXAMINE THE DRAWING LABELED TRAINING ONE"

echo "OTHELLO DESCRIPTION" >> out/${subnum}.out
date >> out/${subnum}.out
 . des.tr
date >> out/${subnum}.out

echo $first "TRAINING" >> out/${subnum}.out
date >> out/${subnum}.out
 . ${first}.tr
date >> out/${subnum}.out

echo "PLEASE EXAMINE THE DRAWING LABELED DIAGRAM ONE"

echo "
SAVINGS ACCOUNT DESCRIPTION
"  >> out/${subnum}.out
date >> out/${subnum}.out
 . des.sa
date >> out/${subnum}.out

 . ${first}.sa
echo "Rate the ease of use for this diagram.
      1-excellent
      2-fair
      3-moderate
      4-poor
      5-terrible."
read rate
echo $first "RATE" $rate >> out/${subnum}.out

echo "PLEASE EXAMINE THE DRAWING LABELED TRAINING TWO"

echo "OTHELLO DESCRIPTION" >> out/${subnum}.out
```

```
date >> out/${subnum}.out
 . des.tr
date >> out/${subnum}.out

echo $second "TRAINING" >> out/${subnum}.out
date >> out/${subnum}.out
 . ${second}.tr
date >> out/${subnum}.out

echo "PLEASE EXAMINE THE DRAWING LABELED DIAGRAM TWO"

echo "
ADVISING DESCRIPTION
" >> out/${subnum}.out
date >> out/${subnum}.out
 . des.ad
date >> out/${subnum}.out

 . ${second}.ad
echo "Rate the ease of use for this diagram.
      1-excellent
      2-fair
      3-moderate
      4-poor
      5-terrible."
read rate
echo $second "RATE" $rate >> out/${subnum}.out

echo "PLEASE EXAMINE THE DRAWING LABELED TRAINING THREE"

echo "OTHELLO DESCRIPTION" >> out/${subnum}.out
date >> out/${subnum}.out
 . des.tr
date >> out/${subnum}.out

echo $third "TRAINING" >> out/${subnum}.out
date >> out/${subnum}.out
 . ${third}.tr
date >> out/${subnum}.out

echo "PLEASE EXAMINE THE DRAWING LABELED DIAGRAM THREE"

echo "
COUNTRY CLUB DESCRIPTION
" >> out/${subnum}.out
date >> out/${subnum}.out
 . des.cc
date >> out/${subnum}.out

 . ${third}.cc
echo "Rate the ease of use for this diagram.
      1-excellent
```

```
      2-fair
      3-moderate
      4-poor
      5-terrible."
read rate
echo $third "RATE" $rate >> out/${subnum}.out

echo "PLEASE EXAMINE THE DRAWING LABELED TRAINING FOUR"

echo "OTHELLO DESCRIPTION" >> out/${subnum}.out
date >> out/${subnum}.out
 . des.tr
date >> out/${subnum}.out

echo $fourth "TRAINING" >> out/${subnum}.out
date >> out/${subnum}.out
 . ${fourth}.tr
date >> out/${subnum}.out

echo "PLEASE EXAMINE THE DRAWING LABELED DIAGRAM FOUR"

echo "
PROJECT MANAGER DESCRIPTION
" >> out/${subnum}.out
date >> out/${subnum}.out
 . des.pm
date >> out/${subnum}.out

 . ${fourth}.pm
echo "Rate the ease of use for this diagram.
      1-excellent
      2-fair
      3-moderate
      4-poor
      5-terrible."
read rate
echo $fourth "RATE" $rate >> out/${subnum}.out

echo "Which design diagram did you like the best, HOS, JACKSON,
      WARNIER-ORR, or YOURDON-CONSTANTINE?"
read choice
echo "DIAGRAM CHOICE" $choice >> out/${subnum}.out

echo "
```

THANK YOU

```
echo "     This is an Higher Order Software [HOS] diagram.  It is a
decomposition tree, that is, a tree of hoxes where each box can be
decomposed or divided into more sub-boxes.  There are two possible
types of decomposition: composition and partition.  Composition is an
'and' function. All of the sub-boxes are performed.  They are executed
from right to left.  Partition is an 'or' function. This is indicated
by conditions associated with arcs coming out of the decomposed box.
The conditions are shown in brackets {}.  Only the one box for which
the condition holds true is executed.
     A module refers to either a single box or a group of boxes.  If a
single box is referred to as a module it should be on the lowest level
i.e. no other boxes below it.  In this diagram 'DISPLAY BOARD' could
be called a module.  If a group of boxes is referred to as a module,
the box on the highest level of the group is referenced, the module
then includes that box and non-module sub-boxes.  When 'CONTINUE PLAY'
is referred to as a module it includes 'SWITCH PLAYER AND OPP' and
'PLAY'.
     In order for an HOS diagram to show iteration, a recursive call
to a module at a higher level is performed.  For example, this is used
to allow players to take turns.  After the first player has moved and
captured, the module 'CONTINUE PLAY' is executed.  Within this module
there is a recursive call to 'PLAY'.  To trace this you would move up
the tree to the box labeled 'PLAY' and start back down the tree with
the new player and opp.

PLEASE HIT RETURN WHEN READY TO CONTINUE"
read again
while test $again != n
do
echo "
```

1. What happens after it is discovered that the current player 'CAN'T MOVE'?

   A. The OPP moves
   B. The OPP wins
   C. The PLAYER must try to move again

HIT RETURN WHEN READY FOR AN EXPLANATION
"

read temp
echo " The correct answer is A. After 'CAN'T MOVE' is displayed the variable 'CAN'T.MOVE' is incremented, the 'PLAYER' and 'OPP' are switched and then a recursive call to 'PLAY'. Again, to trace this you would move back up the tree to the box labeled 'PLAY' then start back down from here. If the variable 'CAN'T.MOVE' is equal to two at this point the game would be over, but with the information given it can't be assumed the OPP would win.

HIT RETURN
"
read temp
echo "

2. Which modules are performed as part of 'PROCESS SEARCH RESULTS'?

A. 'PROCESS NO POSSIBLE MOVE' then 'PROCESS POSSIBLE MOVE'
B. 'PROCESS POSSIBLE MOVE' then 'PROCESS NO POSSIBLE MOVE'
C. Either 'PROCESS NO POSSIBLE MOVE' or 'PROCESS POSSIBLE MOVE'

HIT RETURN WHEN READY FOR AN EXPLANATION

"

read temp
echo " The correct answer is C. The module 'PROCESS SEARCH RESULTS' is decomposed conditionally. This means that only ONE of the sub-modules are performed. The one that is performed is the module with the true condition.

```
HIT RETURN
"
read temp
echo "
```

3. Which module are performed as part of 'GAME OVER'?

   A. 'OTHELLO' then 'DISPLAY WINNER'
   B. 'DISPLAY WINNER' then 'OTHELLO'
   C. 'OTHELLO', 'PLAY' and 'DISPLAY WINNER'

   HIT RETURN WHEN READY FOR AN EXPLANATION

```
"
read temp
echo "    The correct answer is B. The module 'GAME OVER' is an 'and'
decomposition. This means that the sub-modules are performed from
right to left. It first executes 'DISPLAY WINNER' and then it
performs a recursive call to 'OTHELLO'.

HIT RETURN
"

read temp
echo "
```

4. Where would you add a module that would allow a player to ask for the computer´s advice on where he should move next?

   A. Add the module as another conditional out of ´PROCESS MOVE POSITION´
   B. Add the module below ´SETUP´
   C. Add the module as a prompt out of ´GAME OVER´

   HIT RETURN WHEN READY FOR AN EXPLANATION

```
"
read temp
echo "    The correct answer is A.  You wouldn´t want B because this
would limit the player to asking for advice at the beginning of the
game only.  Similarly with C, the player could only ask at the end of
a game.  A, would allow the user to ask for advice before they moved.



"
echo "Would you like to go through the example questions again?[y/n]"
read again
done
```

```
hos.ad


echo "

ADVISING HOS" >> out/${subnum}.out
echo "


       ADVISING SYSTEM
"

echo "
1. What is displayed after an Arts & Sciences course is deleted?

        A. Advising menu
        B. Maintain menu
        C. Update menu

SELECT









"
echo "NUMBER 1" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "C  " $choice >> out/${subnum}.out



echo "


2. What is displayed after the printflag is set to false?

        A. Report menu
        B. Advising menu
        C. Maintain menu

SELECT
```

```
"
echo "NUMBER 2" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "B  " $choice >> out/${subnum}.out


echo "
3. Which report contains the core courses that the student is taking
   or has taken?

        A. FOUR YEAR PROGRESSION REPORT
        B. STUDENT CORE REPORT
        C. CORE REPORT

SELECT




"
echo "NUMBER 3" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "B  " $choice >> out/${subnum}.out
```

echo "

4. Which reports would be the same for all students?

   A. FOUR YEAR PROGRESSION REPORT, CORE REPORT, TECH ELECT REPORT
   B. STUDENT TECH ELECT REPORT, STUDENT CORE REPORT, STUDENT A&S REPORT
   C. FOUR YEAR PROGRESSION REPORT, STUDENT CORE REPORT, STUDENT A&S REPORT

SELECT

"
echo "NUMBER 4" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "A " $choice >> out/${subnum}.out

echo "

5. After a report is printed to the printer, what is displayed?

   A. Advising menu
   B. Report menu
   C. Maintain menu

SELECT

```
"
echo "NUMBER 5" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "B  " $choice >> out/${subnum}.out


echo "
```

6. What module would you select, from the Advising menu module, if you wanted to delete an A&S course that you have since dropped?

    A. MAINTAIN STUDENT INFORMATION
    B. OBTAIN STUDENT INFORMATION
    C. GENERAL REPORTS

SELECT

```
"
echo "NUMBER 6" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "A  " $choice >> out/${subnum}.out
```

```
echo "
```

7. Which module initially sets up the students files, by creating them?

   A. UPDATE A&S
   B. UPDATE CORE
   C. OBTAIN STUDENT INFORMATION

SELECT

```
"
echo "NUMBER 7" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "C  " $choice >> out/${subnum}.out


echo "
```

8. The school wants to add a module that will compare courses that have already been taken, A&S, core and tech. elect., with the four year progression file. From this comparison the module will give ´advice´ as to which courses should be taken the following semester. On which menu should the option be placed to select such a module?

   A. Maintain menu
   B. Report menu
   C. Advising menu

SELECT

```
"
echo "NUMBER 8" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "C  " $choice >> out/${subnum}.out



echo "
```

9. Which module determines if a report is to be output or not?

    A. PROCESS MAINTAIN MENU CHOICE
    B. CHECK PRINT FLAG
    C. REPORT MENU

SELECT

```
"
echo "NUMBER 9" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "B  " $choice >> out/${subnum}.out
```

```
echo "
```

10. If you were changing some technical elective courses and wanted to quit what item(s) would you select from which menu(s)?

   A. Select 'MAINTAIN STUDENT INFORMATION' from the 'UPDATE TECH ELECT MENU', Select 'ADVISING' from the 'MAINTAIN MENU', and Select 'EXIT PROGRAM' from the 'ADVISING MENU'
   B. Select 'EXIT PROGRAM' from the 'ADVISING MENU'
   C. Select 'PRINTFLAG = FALSE' from the 'REPORT MENU', Select 'EXIT PROGRAM' from the 'ADVISING MENU'

SELECT

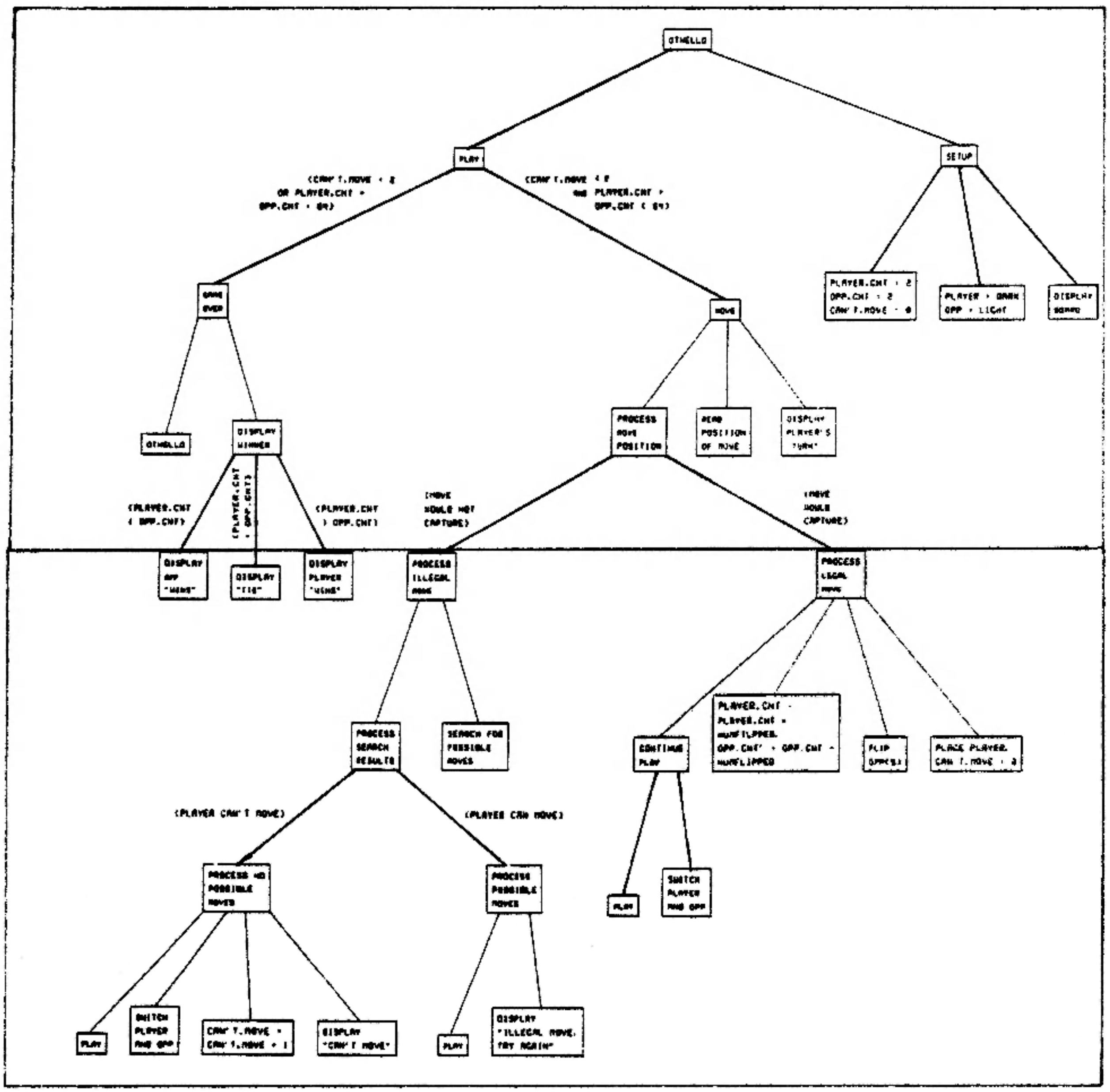
```
"
echo "NUMBER 10" >> out/${subnum}.out
date >> out/${subnum}.out
read choice
date >> out/${subnum}.out
echo "A  " $choice "

" >> out/${subnum}.out
```

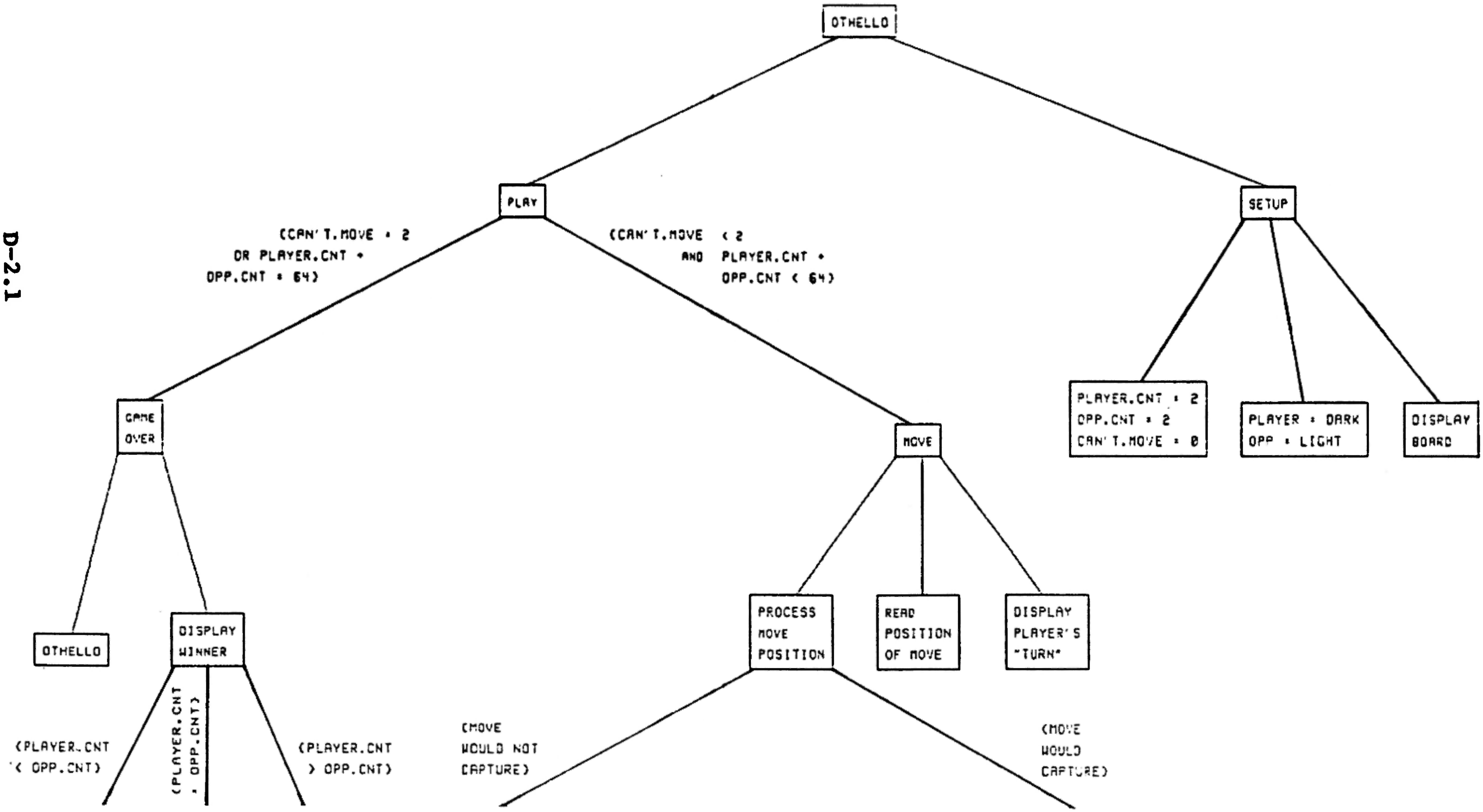
Appendix D

Diagrams

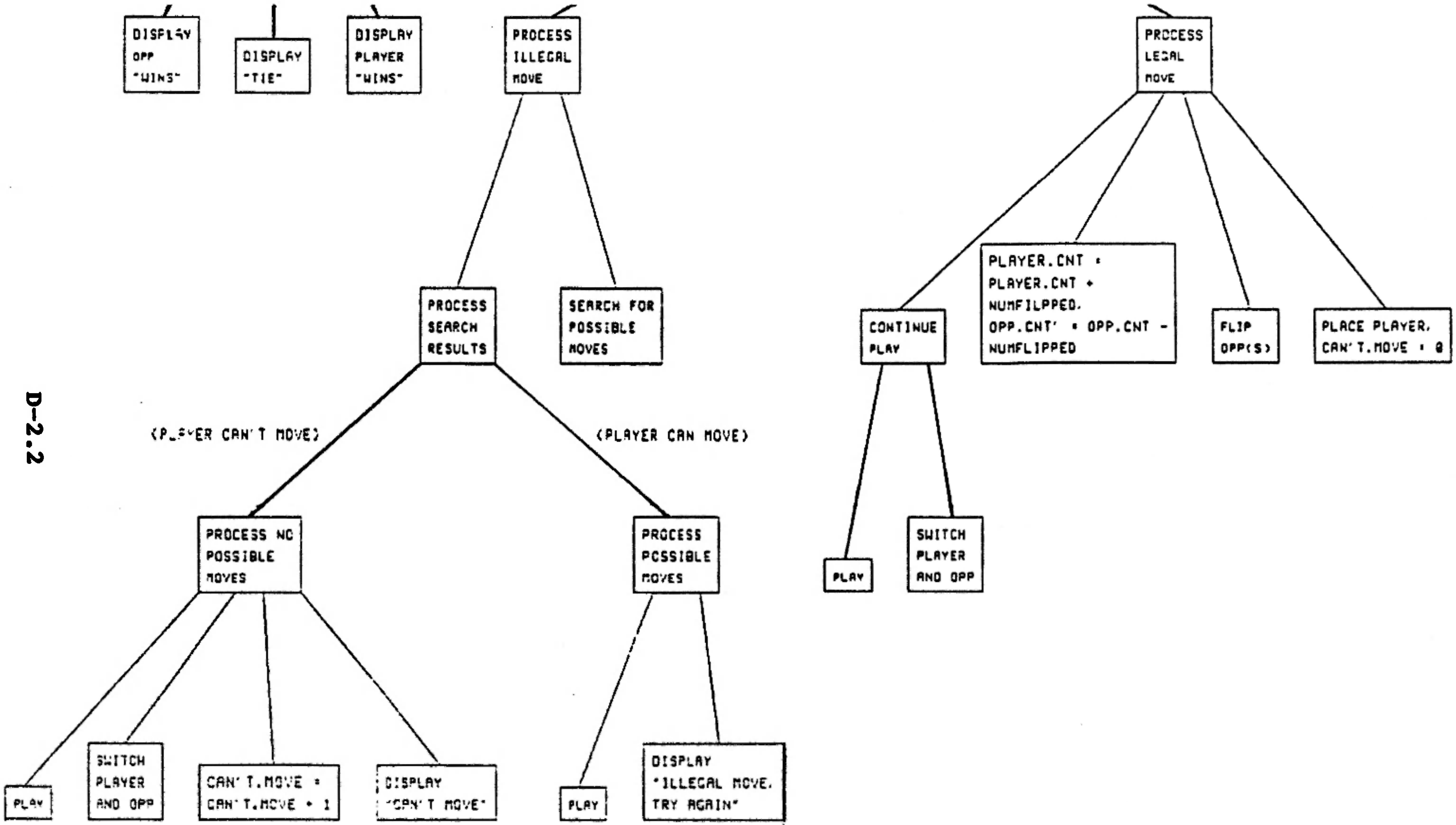
HOS Othello



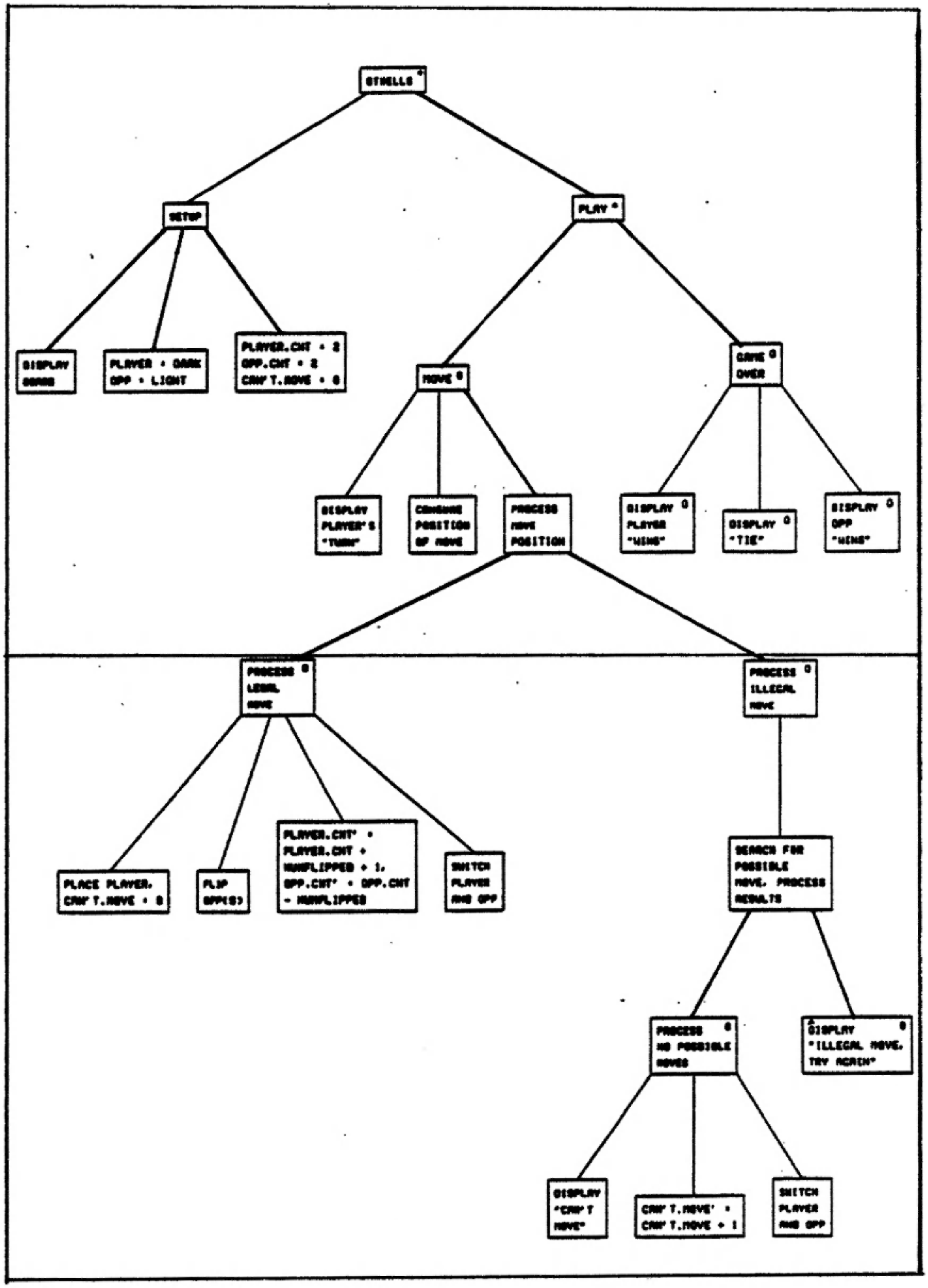
OTHELLO
PLAY
SETUP
GAME OVER
MOVE
OTHELLO
DISPLAY WINNER
PROCESS MOVE POSITION
READ POSITION OF MOVE
DISPLAY PLAYER'S TURN
DISPLAY "TIE"
PROCESS ILLEGAL MOVE
PROCESS LEGAL MOVE
PROCESS SEARCH RESULTS
SEARCH FOR POSSIBLE MOVES
CONTINUE PLAY
FLIP
(PLAYER CAN'T MOVE)
(PLAYER CAN MOVE)
PROCESS NO POSSIBLE MOVES
PROCESS POSSIBLE MOVES
PLAY
SWITCH PLAYER AND OPP
PLAY
SWITCH PLAYER AND OPP
DISPLAY "CAN'T MOVE"
PLAY
DISPLAY "ILLEGAL MOVE, TRY AGAIN"

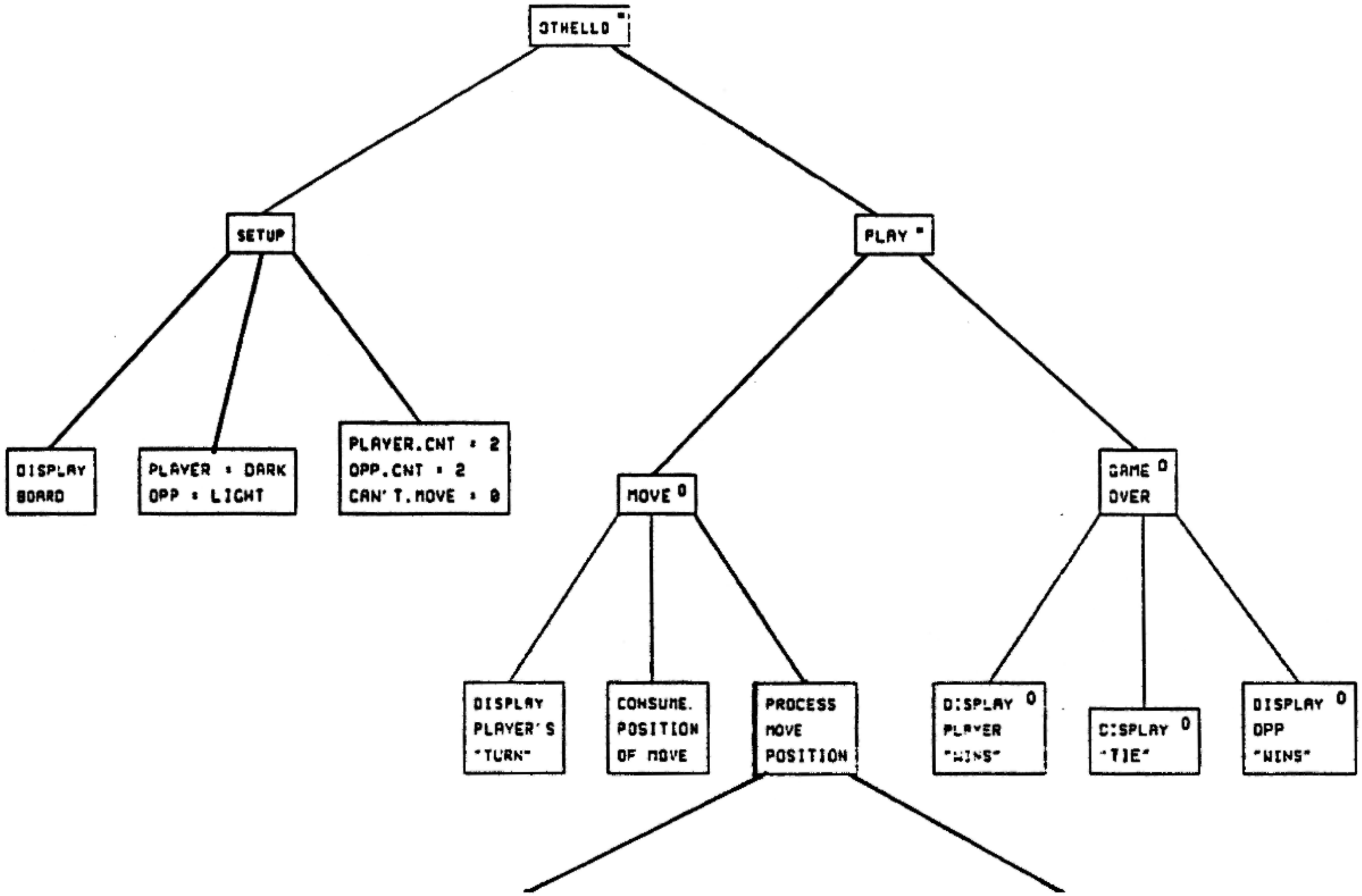


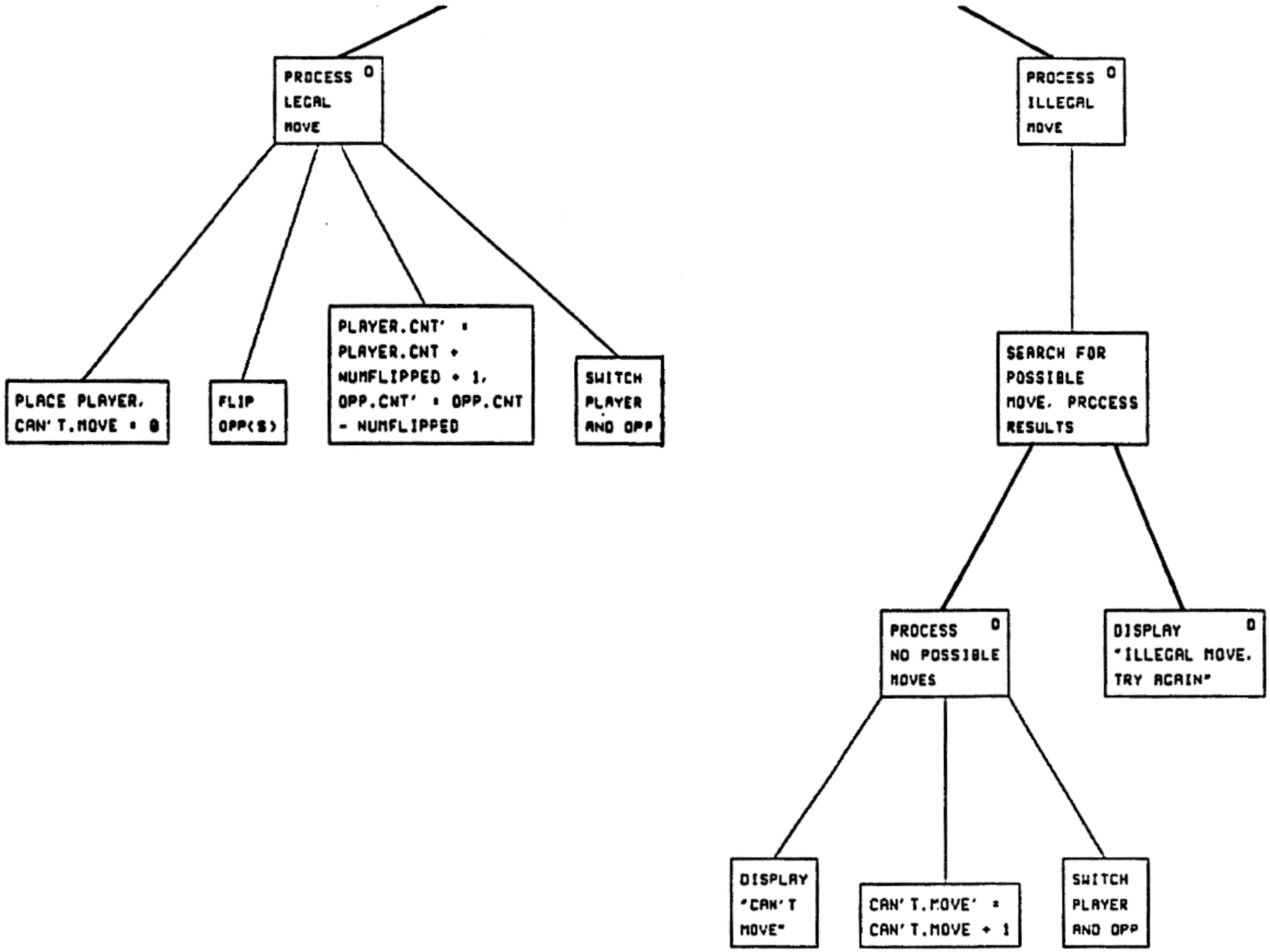
OTHELLO
PLAY
SETUP
(CAN'T.MOVE = 2
OR PLAYER.CNT +
OPP.CNT = 64)
(CAN'T.MOVE < 2
AND PLAYER.CNT +
OPP.CNT < 64)
PLAYER.CNT = 2
OPP.CNT = 2
CAN'T.MOVE = 0
PLAYER = DARK
OPP = LIGHT
DISPLAY
BOARD
GAME
OVER
MOVE
OTHELLO
DISPLAY
WINNER
PROCESS
MOVE
POSITION
READ
POSITION
OF MOVE
DISPLAY
PLAYER'S
"TURN"
(PLAYER.CNT
< OPP.CNT)
(PLAYER.CNT
= OPP.CNT)
(PLAYER.CNT
> OPP.CNT)
(MOVE
WOULD NOT
CAPTURE)
(MOVE
WOULD
CAPTURE)


DISPLAY OPP "WINS"
DISPLAY "TIE"
DISPLAY PLAYER "WINS"
PROCESS ILLEGAL MOVE
PROCESS LEGAL MOVE
PROCESS SEARCH RESULTS
SEARCH FOR POSSIBLE MOVES
CONTINUE PLAY
PLAYER.CNT = PLAYER.CNT + NUMFILPPED. OPP.CNT' = OPP.CNT - NUMFLIPPED
FLIP OPP(S)
PLACE PLAYER, CAN'T.MOVE = 0
(PLAYER CAN'T MOVE)
(PLAYER CAN MOVE)
PROCESS NO POSSIBLE MOVES
PROCESS POSSIBLE MOVES
PLAY
SWITCH PLAYER AND OPP
PLAY
SWITCH PLAYER AND OPP
CAN'T.MOVE = CAN'T.MOVE + 1
DISPLAY "CAN'T MOVE"
PLAY
DISPLAY "ILLEGAL MOVE, TRY AGAIN"

Jackson Othello




OTHELLO *
SETUP
PLAY *
DISPLAY BOARD
PLAYER = DARK
OPP = LIGHT
PLAYER.CNT = 2
OPP.CNT = 2
CAN'T.MOVE = 0
MOVE O
GAME OVER O
DISPLAY PLAYER'S "TURN"
CONSUME. POSITION OF MOVE
PROCESS MOVE POSITION
DISPLAY PLAYER "WINS" O
DISPLAY "TIE" O
DISPLAY OPP "WINS" O

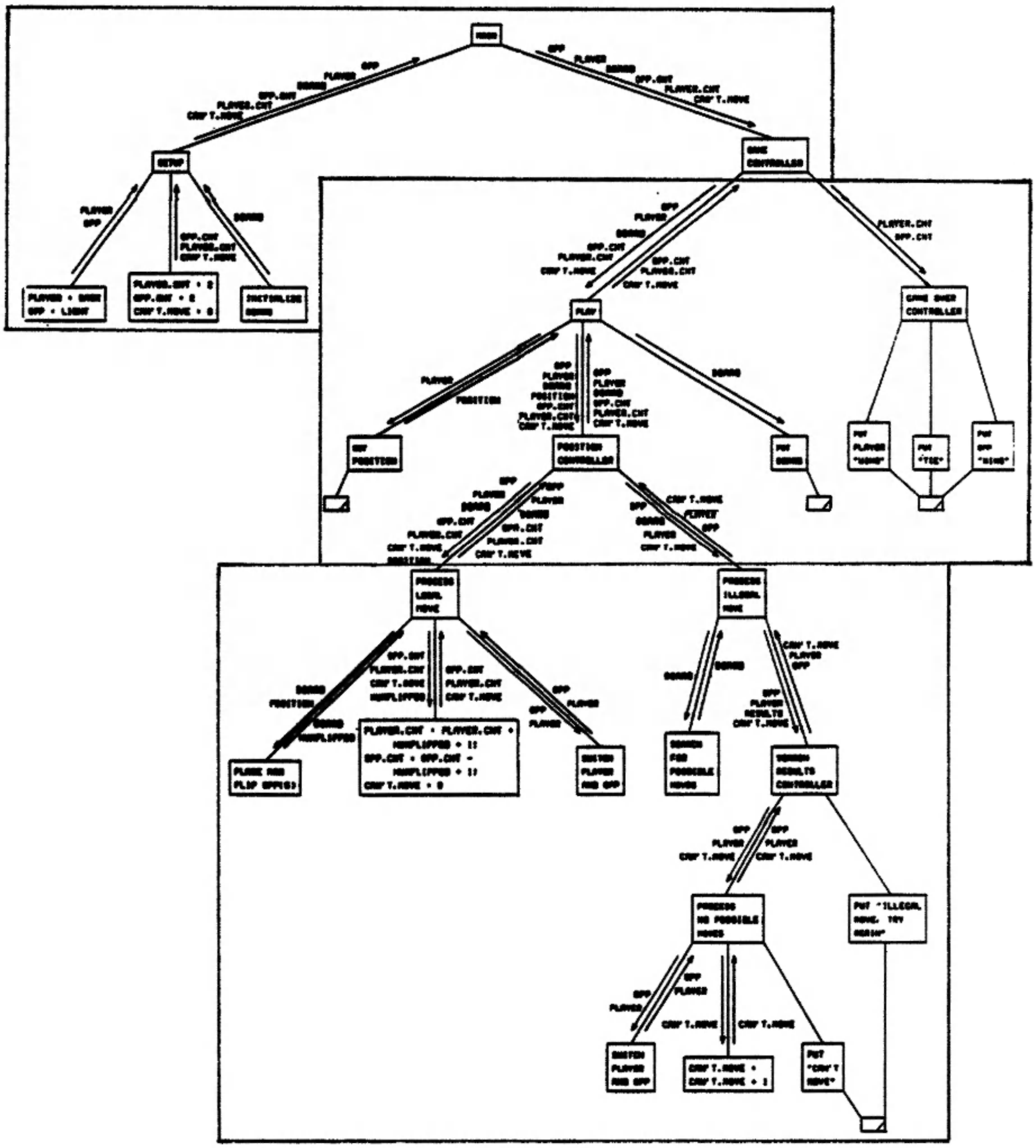

PROCESS LEGAL MOVE 0
PLACE PLAYER. CAN'T.MOVE = 0
FLIP OPP(S)
PLAYER.CNT' = PLAYER.CNT + NUMFLIPPED + 1, OPP.CNT' = OPP.CNT - NUMFLIPPED
SWITCH PLAYER AND OPP
PROCESS ILLEGAL MOVE 0
SEARCH FOR POSSIBLE MOVE. PROCESS RESULTS
PROCESS NO POSSIBLE MOVES 0
DISPLAY "ILLEGAL MOVE. TRY AGAIN" 0
DISPLAY "CAN'T MOVE"
CAN'T.MOVE' = CAN'T.MOVE + 1
SWITCH PLAYER AND OPP

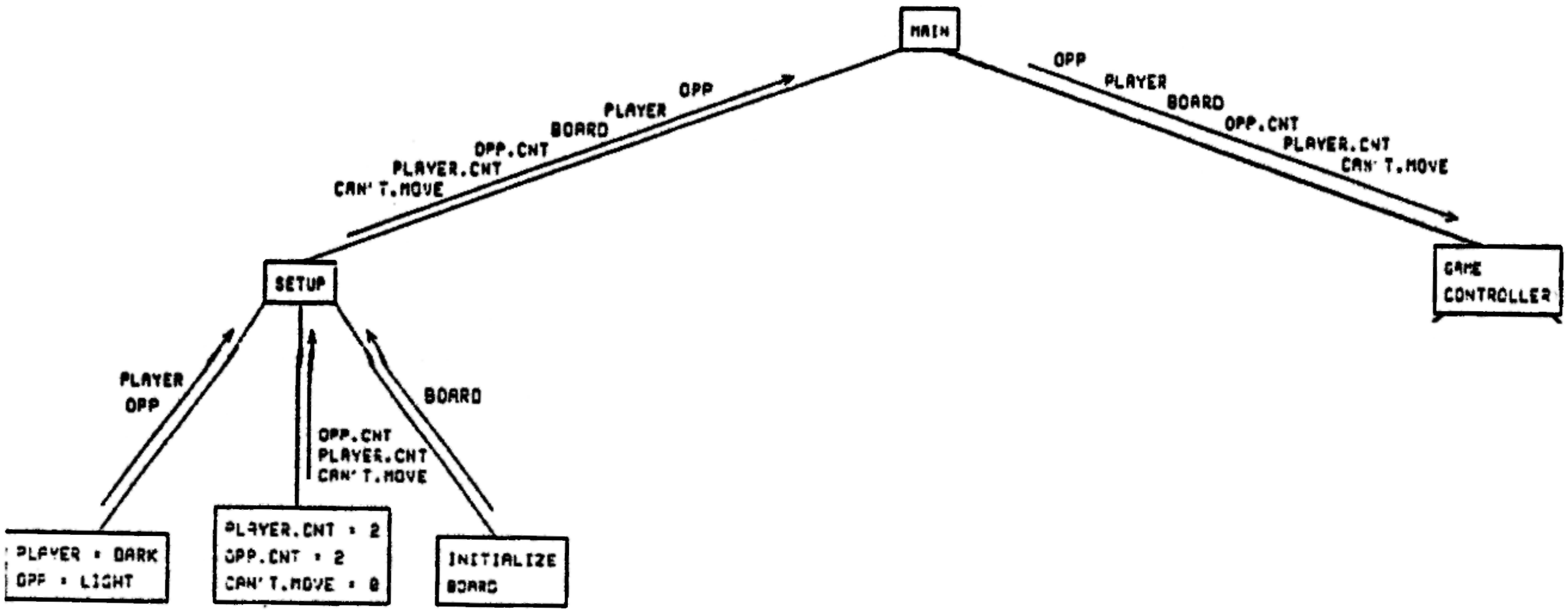
Warnier-Orr Othello

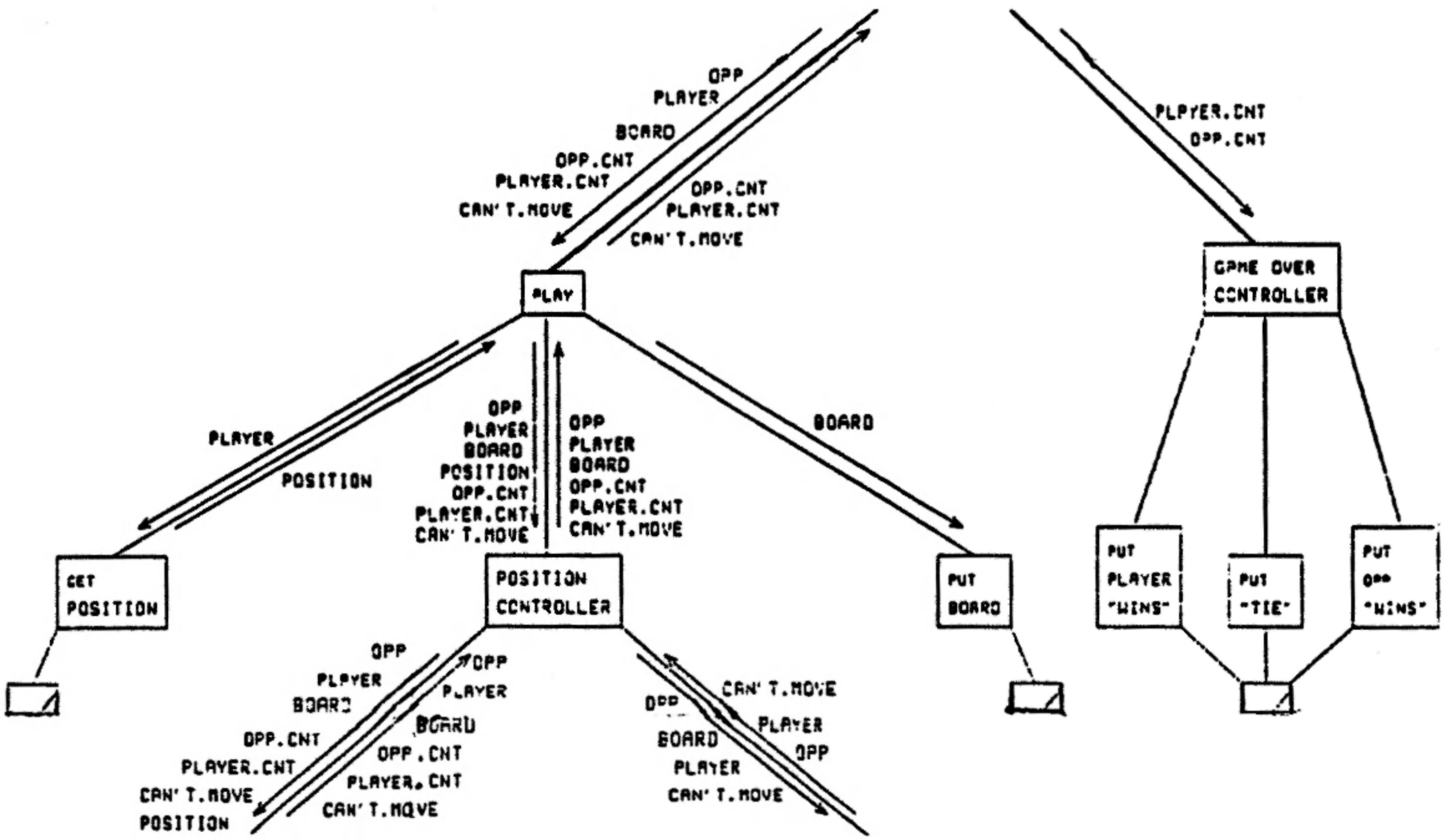
```
OTHELLO
(1,N)?0
    SETUP
        DISPLAY BOARD
        PLAYER = DARK
        OPP = LIGHT
        PLAYER.CNT = 2
        OPP.CNT = 2
        CAN'T.MOVE = 0
        SET END OF PLAY TO FALSE
    PLAY
    (1,P)?1
        MOVE
        (0,1)?2
            DISPLAY PLAYER'S "TURN"
            READ POSITION OF MOVE
            PROCESS
            MOVE
            POSITION
                PROCESS
                LEGAL
                MOVE
                (0,1)?4
                    PLACE PLAYER
                    CAN'T.MOVE = 0
                    FLIP OPP(S)
                    PLAYER.CNT' = PLAYER.CNT +
                        NUMFLIPPED + 1
                    OPP.CNT' = OPP.CNT -
                        NUMFLIPPED
                    SWITCH PLAYER AND OPP
                ⊕
                PROCESS
                ILLEGAL
                MOVE
                (0,1)?5
                    SEARCH FOR POSSIBLE MOVES
                    PORCESS
                    SEARCH
                    RESULTS
                        PROCESS
                        POSSIBLE
                        MOVE
                        (0,1)?9
                            DISPLAY "ILLEGAL MOVE.
                                     TRY AGAIN"
                        ⊕
                        PROCESS
                        NO POSS.
                        MOVE
                        (0,1)?10
                            DISPLAY "CAN'T MOVE"
                            CAN'T.MOVE' = CAN'T.MOVE + 1
                            SWITCH PLAYER AND OPP
        ⊕
        GAME
        OVER
        (0,1)?3
            PROCESS
            WINNER
                DISPLAY PLAYER "WINS"
                 (0,1)?6
                ⊕
                DISPLAY "TIE"
                 (0,1)?7
                ⊕
                DISPLAY OPP "WINS"
                 (0,1)?8
            SET END OF PLAY TO TRUE
```

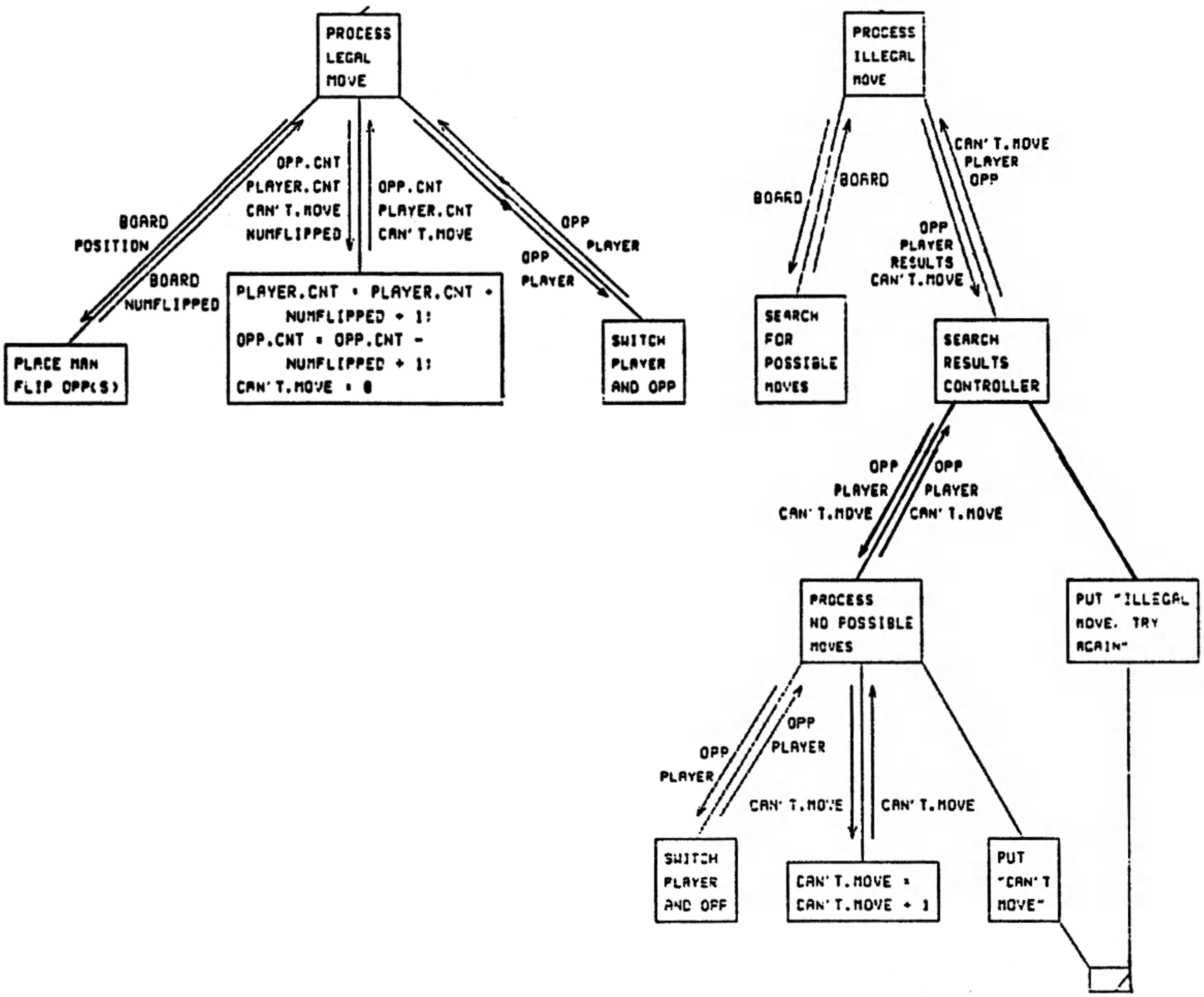
?0 - SYSTEM IS SHUT OFF
?1 - END OF PLAY IS TRUE
?2 - CAN'T.MOVE < 2 AND
     PLAYER.CNT + OPP.CNT < 64
?3 - CAN'T.MOVE = 2 OR
     PLAYER.CNT + OPP.CNT = 64
?4 - MOVE WOULD CAPTURE
?5 - MOVE WOULD NOT CAPTURE
?6 - PLAYER.CNT > OPP.CNT
?7 - PLAYER.CNT = OPP.CNT
?8 - PLAYER.CNT < OPP.CNT
?9 - PLAYER CAN MOVE
?10 - PLAYER CAN NOT MOVE

Yourdon-Constantine
Othello

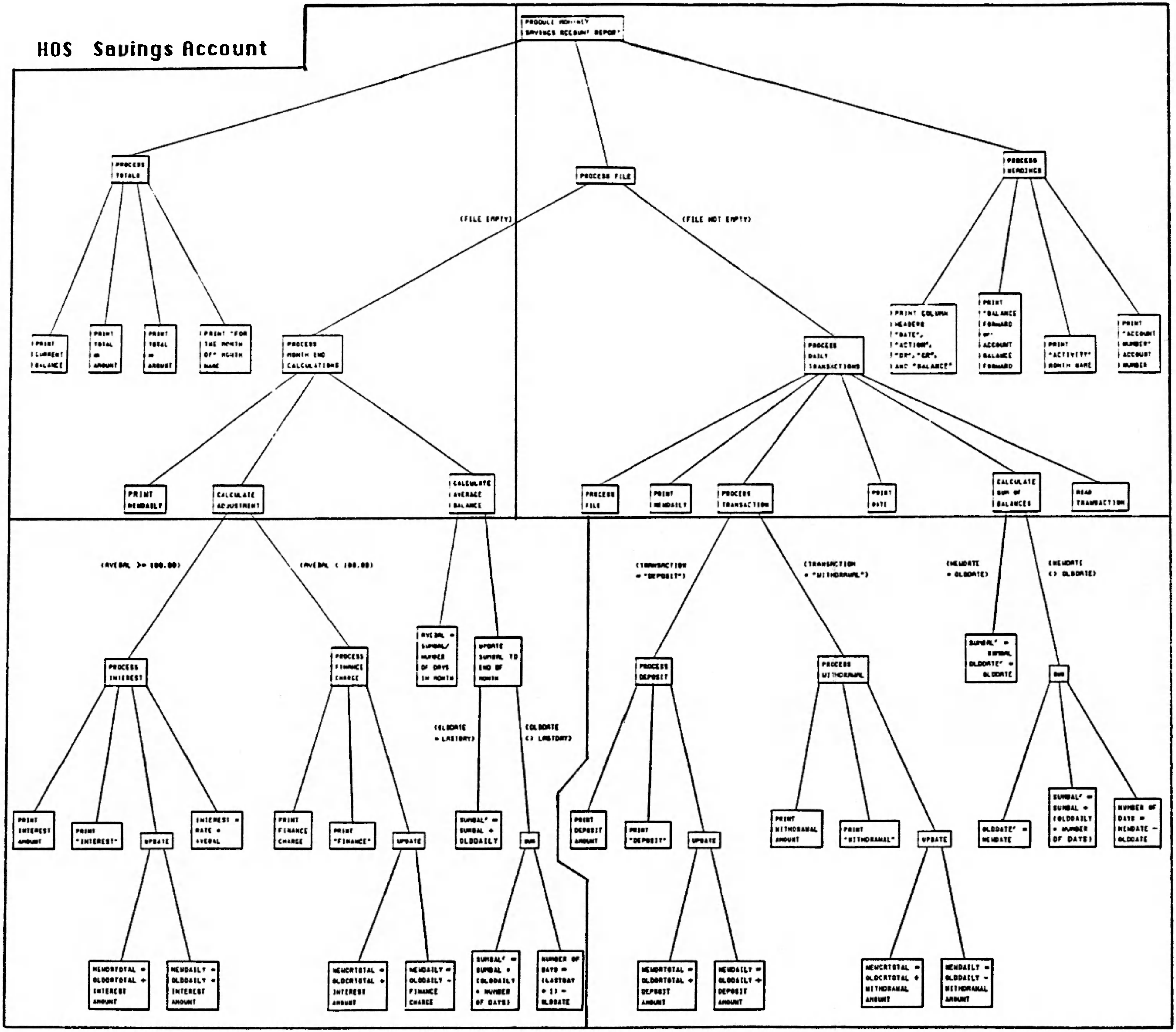


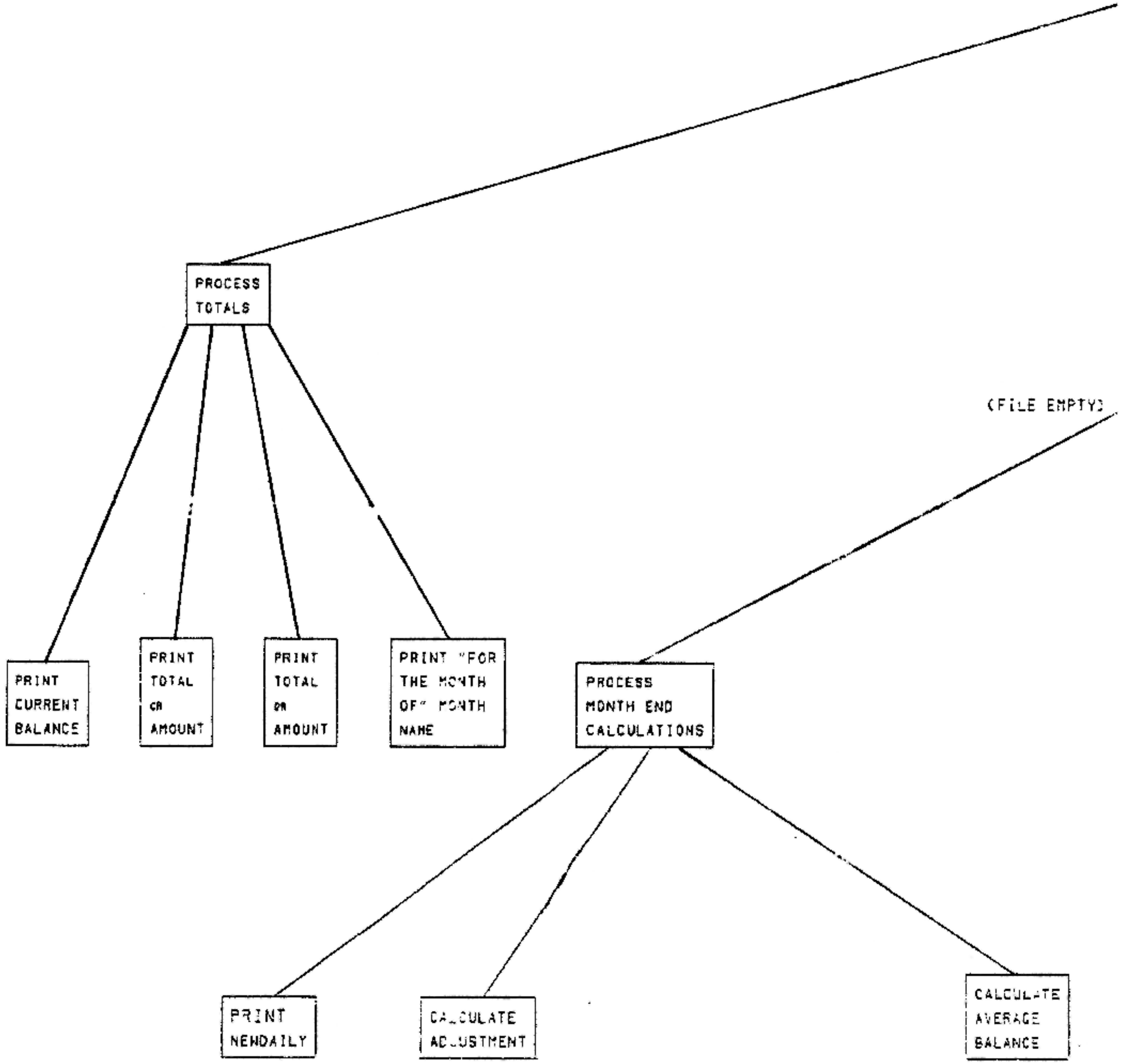

MAIN
OPP
PLAYER
BOARD
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
OPP
PLAYER
BOARD
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
SETUP
GAME CONTROLLER
PLAYER
OPP
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
BOARD
PLAYER = DARK
OPP = LIGHT
PLAYER.CNT = 2
OPP.CNT = 2
CAN'T.MOVE = 0
INITIALIZE BOARD

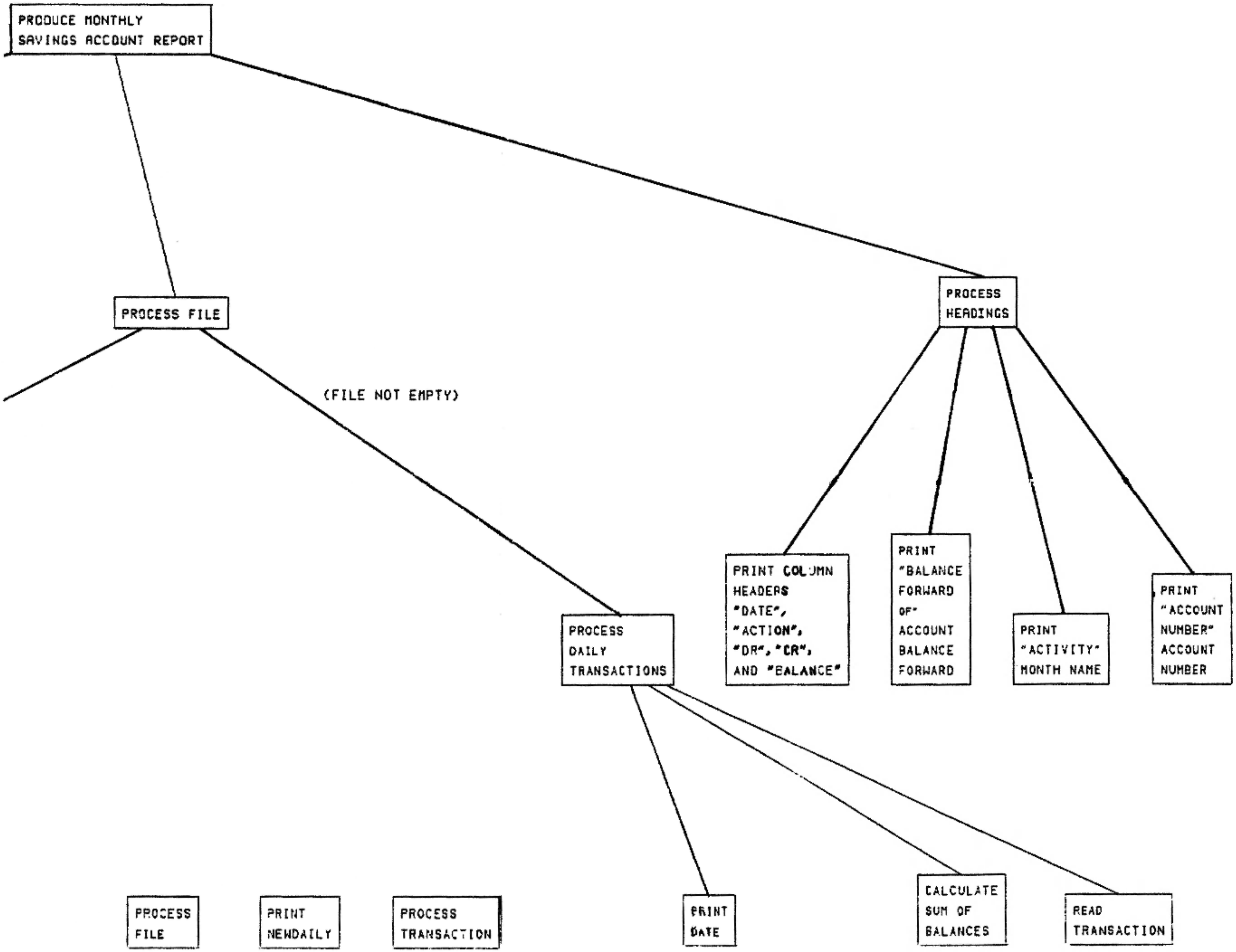

OPP
PLAYER
BOARD
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
PLAYER.CNT
OPP.CNT
PLAY
GAME OVER CONTROLLER
PLAYER
POSITION
OPP
PLAYER
BOARD
POSITION
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
OPP
PLAYER
BOARD
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
BOARD
GET POSITION
POSITION CONTROLLER
PUT BOARD
PUT PLAYER "WINS"
PUT "TIE"
PUT OPP "WINS"
OPP
PLAYER
BOARD
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
POSITION
OPP
PLAYER
BOARD
OPP.CNT
PLAYER.CNT
CAN'T.MOVE
CAN'T.MOVE
PLAYER
OPP
OPP
BOARD
PLAYER
CAN'T.MOVE

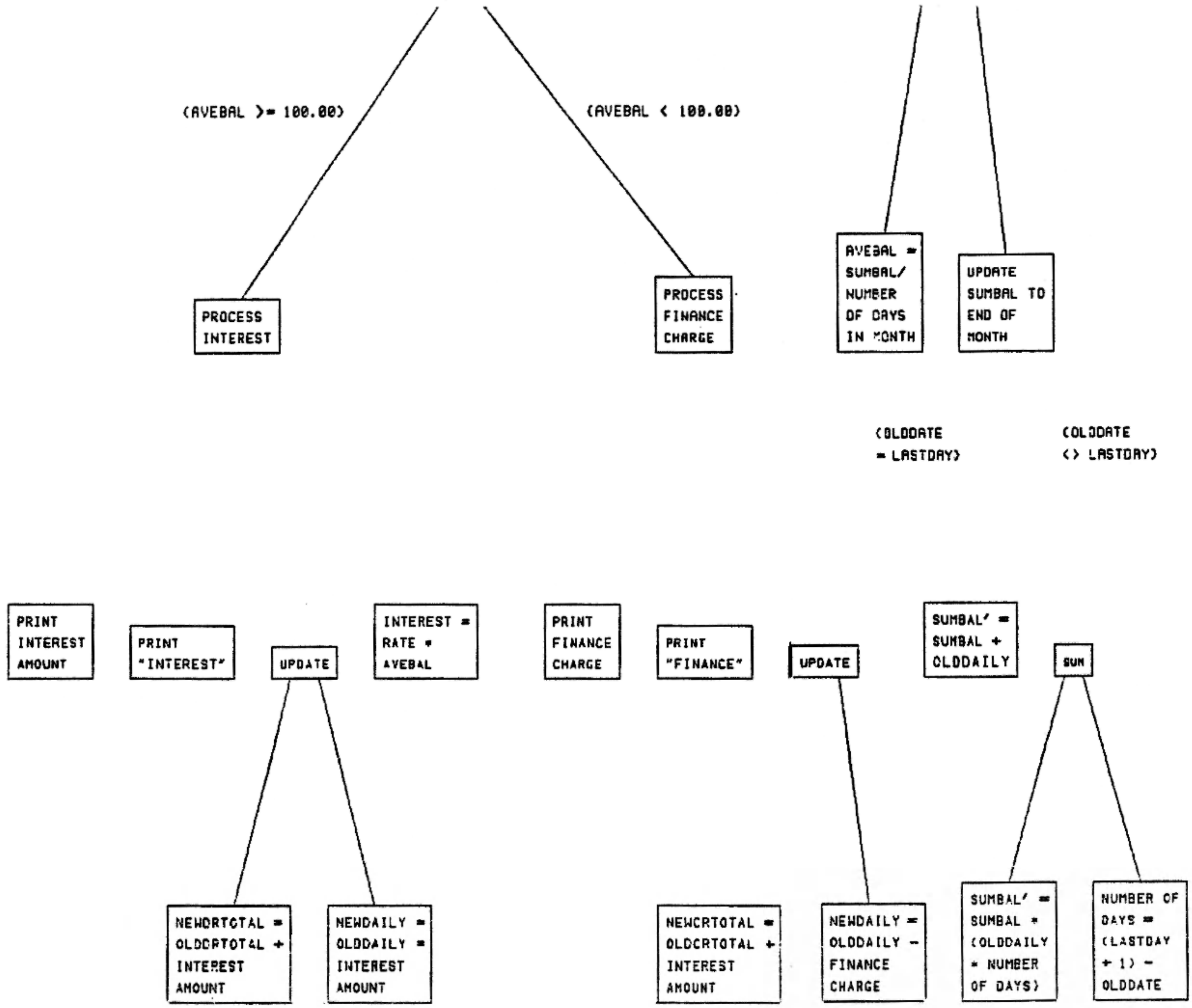

PROCESS LEGAL MOVE
BOARD POSITION
BOARD NUMFLIPPED
OPP.CNT PLAYER.CNT CAN'T.MOVE NUMFLIPPED
OPP.CNT PLAYER.CNT CAN'T.MOVE
OPP PLAYER
OPP PLAYER
PLACE MAN FLIP OPP(S)
PLAYER.CNT = PLAYER.CNT + NUMFLIPPED + 1;
OPP.CNT = OPP.CNT - NUMFLIPPED + 1;
CAN'T.MOVE = 0
SWITCH PLAYER AND OPP
PROCESS ILLEGAL MOVE
BOARD
BOARD
CAN'T.MOVE PLAYER OPP
OPP PLAYER RESULTS CAN'T.MOVE
SEARCH FOR POSSIBLE MOVES
SEARCH RESULTS CONTROLLER
OPP PLAYER CAN'T.MOVE
OPP PLAYER CAN'T.MOVE
PROCESS NO POSSIBLE MOVES
PUT "ILLEGAL MOVE. TRY AGAIN"
OPP PLAYER
OPP PLAYER
CAN'T.MOVE
CAN'T.MOVE
SWITCH PLAYER AND OPP
CAN'T.MOVE = CAN'T.MOVE + 1
PUT "CAN'T MOVE"

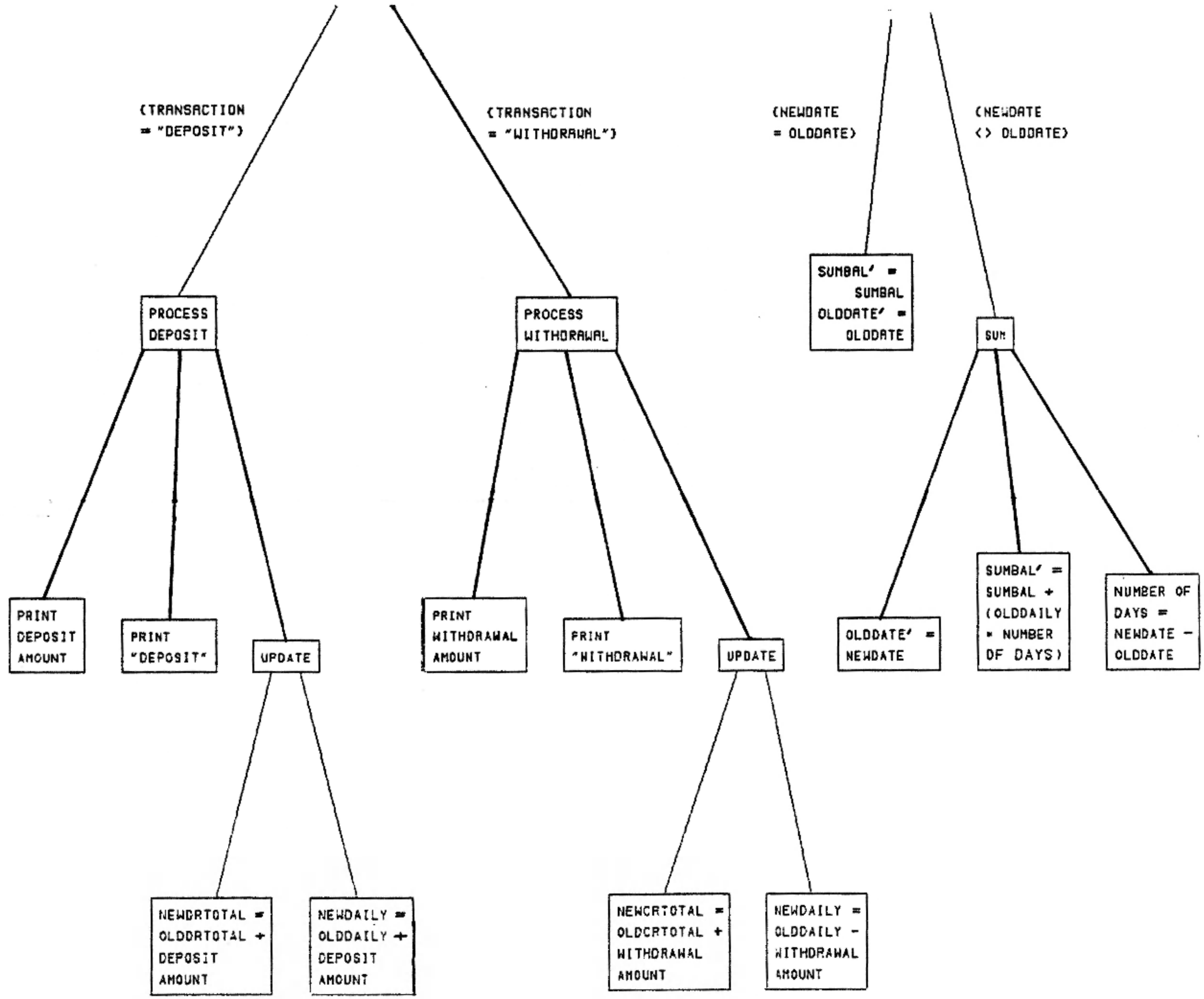
HOS Savings Account



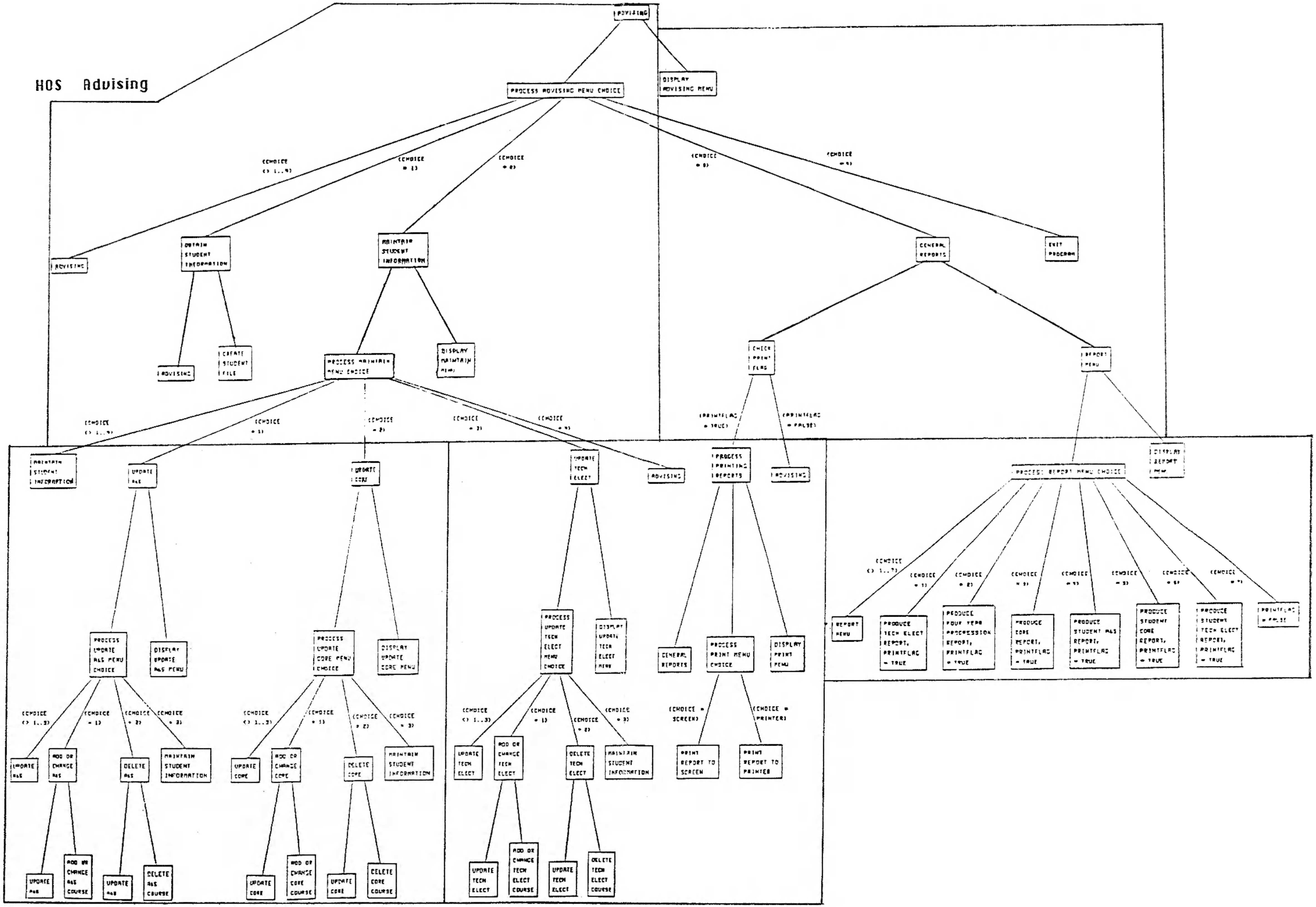

PROCESS TOTALS
(FILE EMPTY)
PRINT CURRENT BALANCE
PRINT TOTAL CR AMOUNT
PRINT TOTAL DR AMOUNT
PRINT "FOR THE MONTH OF" MONTH NAME
PROCESS MONTH END CALCULATIONS
PRINT NEWDAILY
CALCULATE ADJUSTMENT
CALCULATE AVERAGE BALANCE

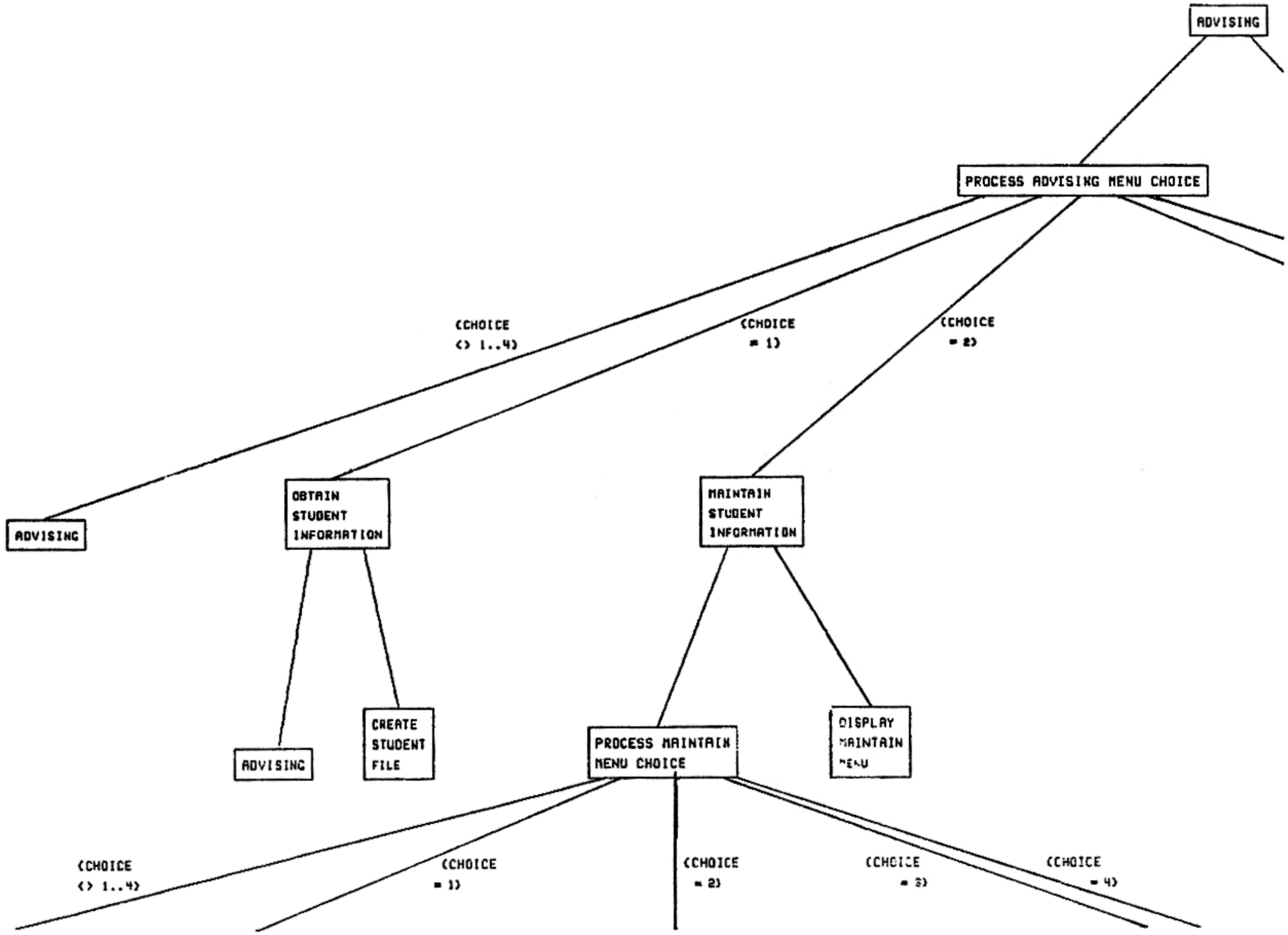

PRODUCE MONTHLY SAVINGS ACCOUNT REPORT
PROCESS FILE
(FILE NOT EMPTY)
PROCESS HEADINGS
PROCESS DAILY TRANSACTIONS
PRINT COLUMN HEADERS "DATE", "ACTION", "DR", "CR", AND "BALANCE"
PRINT "BALANCE FORWARD OF" ACCOUNT BALANCE FORWARD
PRINT "ACTIVITY" MONTH NAME
PRINT "ACCOUNT NUMBER" ACCOUNT NUMBER
PROCESS FILE
PRINT NEWDAILY
PROCESS TRANSACTION
PRINT DATE
CALCULATE SUM OF BALANCES
READ TRANSACTION

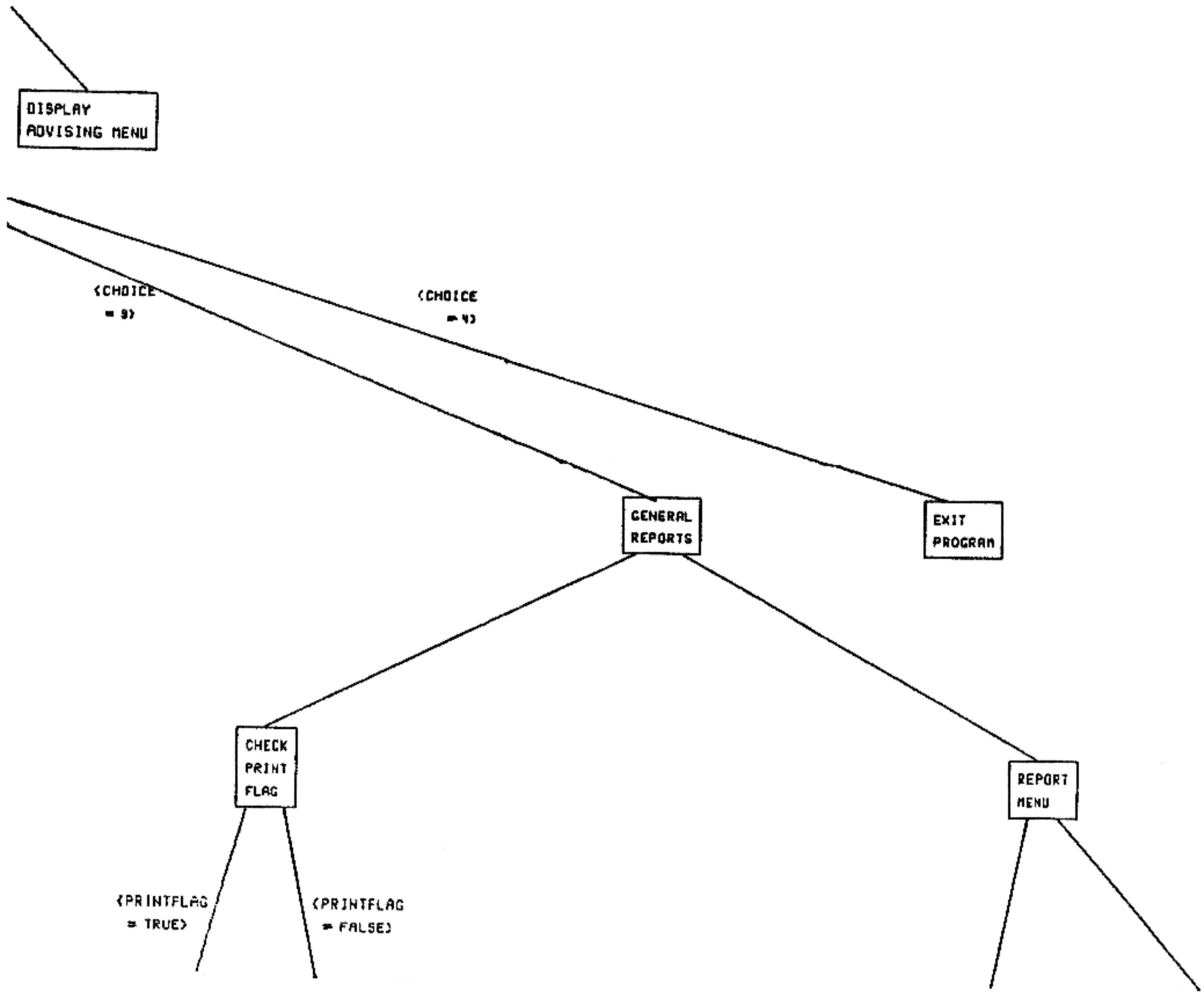

(AVEBAL >= 100.00)
(AVEBAL < 100.00)
PROCESS INTEREST
PROCESS FINANCE CHARGE
AVEBAL = SUMBAL/ NUMBER OF DAYS IN MONTH
UPDATE SUMBAL TO END OF MONTH
(OLDDATE = LASTDAY)
(OLDDATE <> LASTDAY)
PRINT INTEREST AMOUNT
PRINT "INTEREST"
UPDATE
INTEREST = RATE * AVEBAL
PRINT FINANCE CHARGE
PRINT "FINANCE"
UPDATE
SUMBAL' = SUMBAL + OLDDAILY
SUM
NEWCRTOTAL = OLDCRTOTAL + INTEREST AMOUNT
NEWDAILY = OLDDAILY + INTEREST AMOUNT
NEWCRTOTAL = OLDCRTOTAL + INTEREST AMOUNT
NEWDAILY = OLDDAILY - FINANCE CHARGE
SUMBAL' = SUMBAL + (OLDDAILY * NUMBER OF DAYS)
NUMBER OF DAYS = (LASTDAY + 1) - OLDDATE

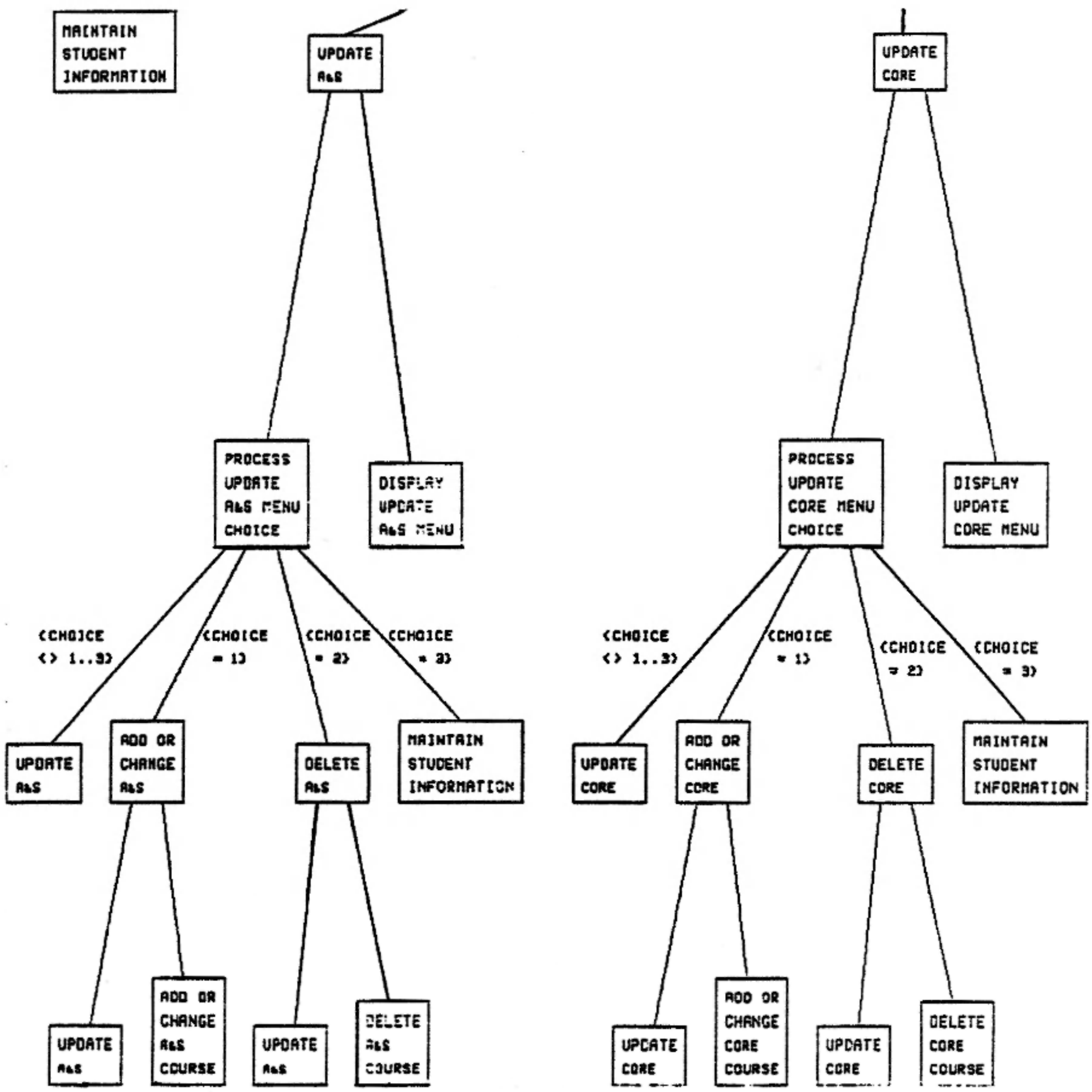

(TRANSACTION = "DEPOSIT")
(TRANSACTION = "WITHDRAWAL")
(NEWDATE = OLDDATE)
(NEWDATE <> OLDDATE)
PROCESS DEPOSIT
PROCESS WITHDRAWAL
SUMBAL' = SUMBAL OLDDATE' = OLDDATE
SUM
PRINT DEPOSIT AMOUNT
PRINT "DEPOSIT"
UPDATE
PRINT WITHDRAWAL AMOUNT
PRINT "WITHDRAWAL"
UPDATE
OLDDATE' = NEWDATE
SUMBAL' = SUMBAL + (OLDDAILY * NUMBER OF DAYS)
NUMBER OF DAYS = NEWDATE − OLDDATE
NEWDRTOTAL = OLDDRTOTAL + DEPOSIT AMOUNT
NEWDAILY = OLDDAILY + DEPOSIT AMOUNT
NEWCRTOTAL = OLDCRTOTAL + WITHDRAWAL AMOUNT
NEWDAILY = OLDDAILY − WITHDRAWAL AMOUNT

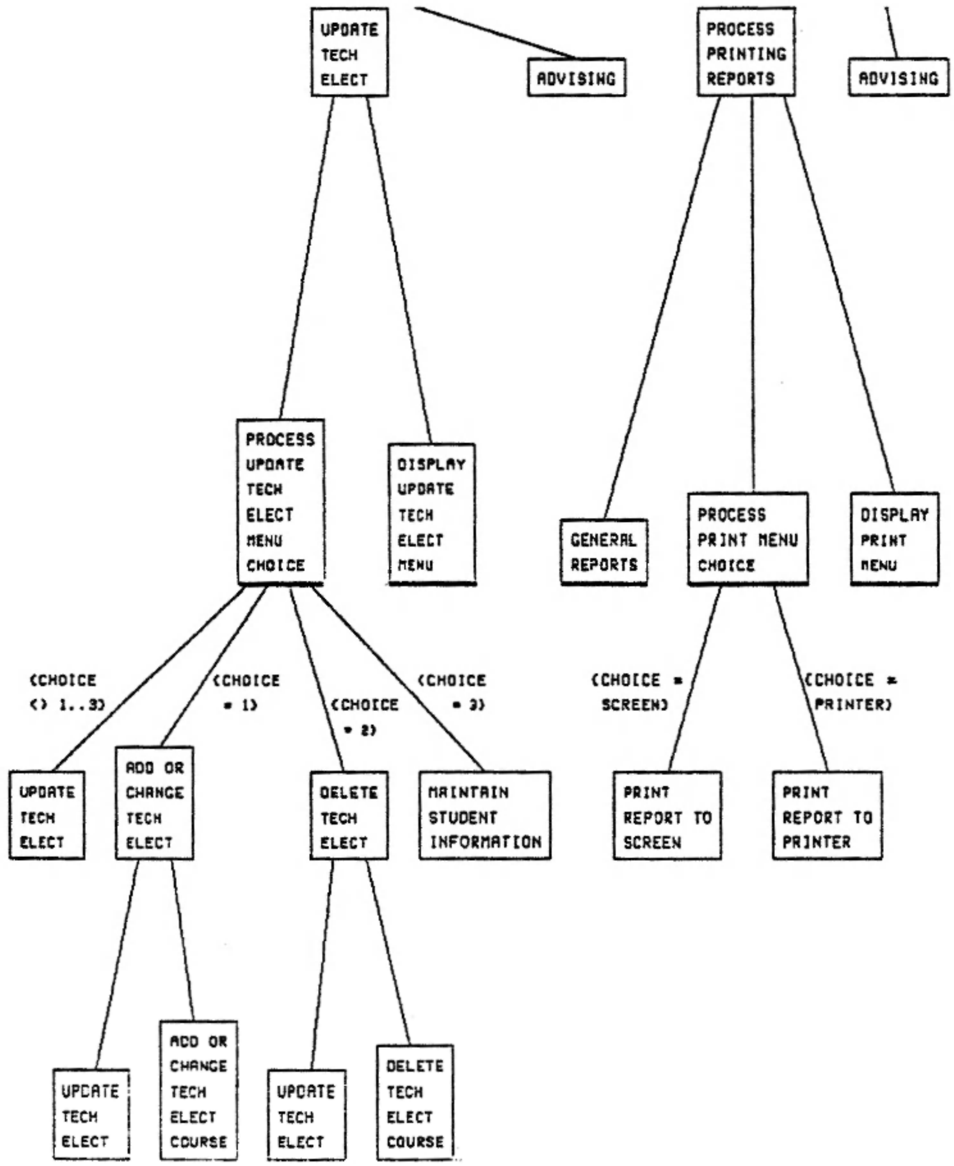
HOS Advising

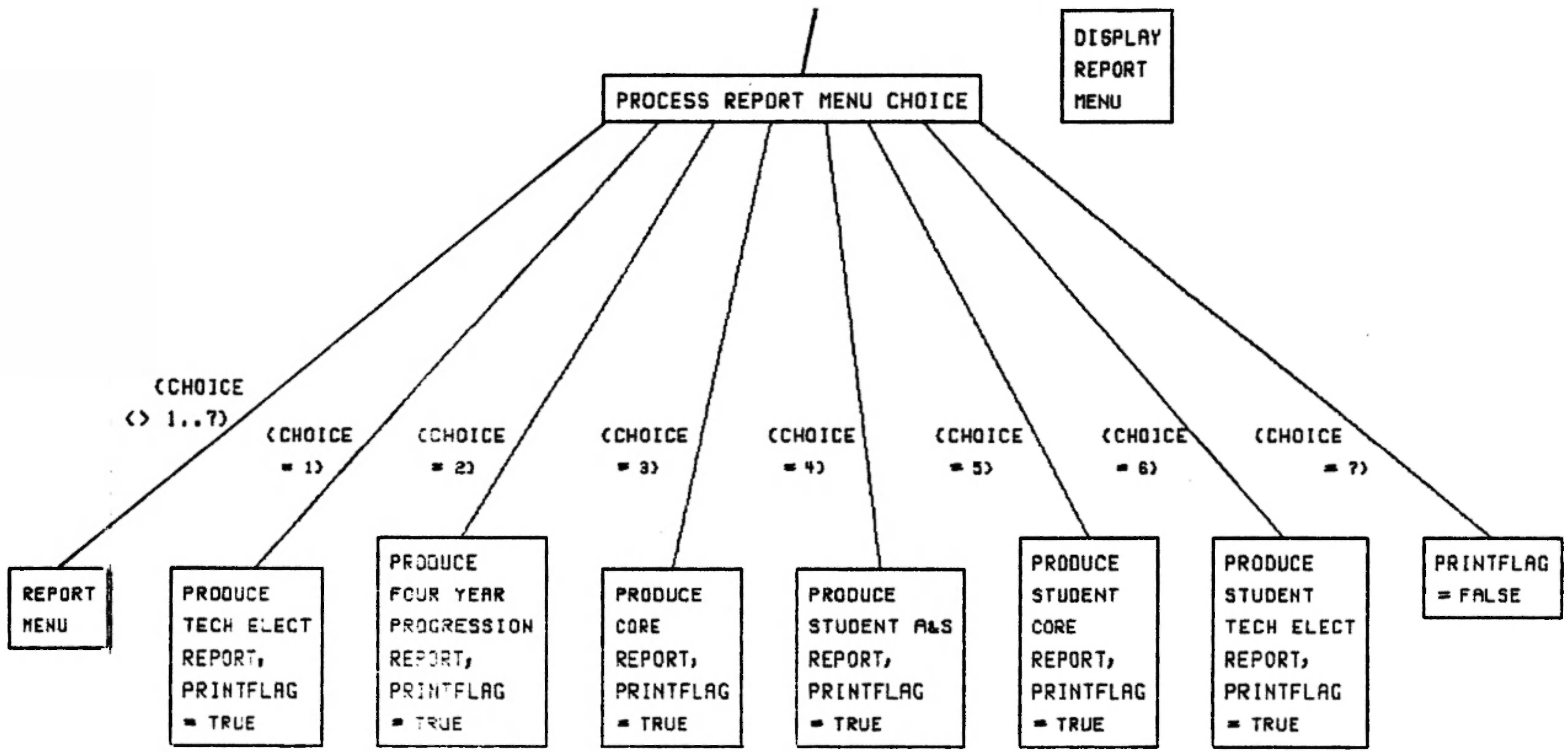



ADVISING
PROCESS ADVISING MENU CHOICE
(CHOICE <> 1..4)
(CHOICE = 1)
(CHOICE = 2)
ADVISING
OBTAIN STUDENT INFORMATION
MAINTAIN STUDENT INFORMATION
ADVISING
CREATE STUDENT FILE
PROCESS MAINTAIN MENU CHOICE
DISPLAY MAINTAIN MENU
(CHOICE <> 1..4)
(CHOICE = 1)
(CHOICE = 2)
(CHOICE = 3)
(CHOICE = 4)

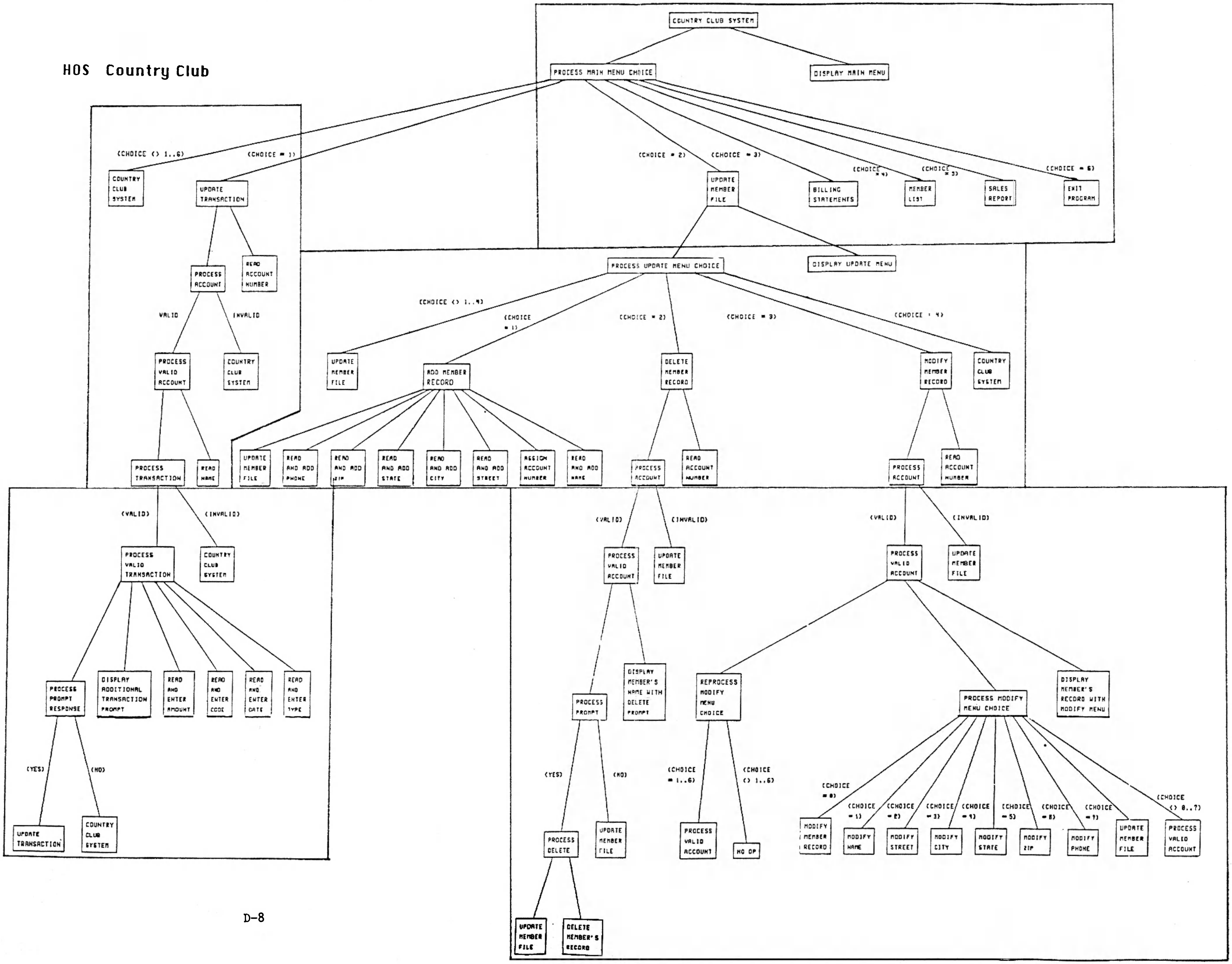

DISPLAY
ADVISING MENU
<CHOICE
= 3>
<CHOICE
= 4>
GENERAL
REPORTS
EXIT
PROGRAM
CHECK
PRINT
FLAG
REPORT
MENU
<PRINTFLAG
= TRUE>
<PRINTFLAG
= FALSE>

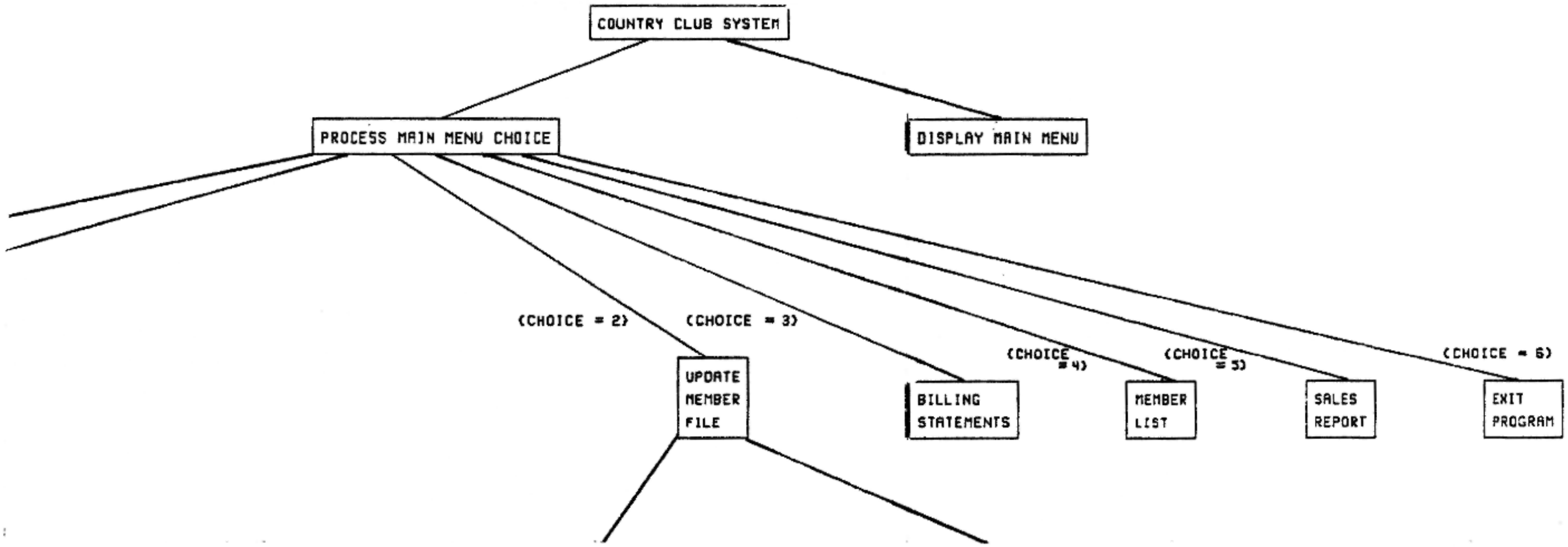

MAINTAIN STUDENT INFORMATION
UPDATE A&S
UPDATE CORE
PROCESS UPDATE A&S MENU CHOICE
DISPLAY UPDATE A&S MENU
PROCESS UPDATE CORE MENU CHOICE
DISPLAY UPDATE CORE MENU
(CHOICE <> 1..3)
(CHOICE = 1)
(CHOICE = 2)
(CHOICE = 3)
UPDATE A&S
ADD OR CHANGE A&S
DELETE A&S
MAINTAIN STUDENT INFORMATION
UPDATE CORE
ADD OR CHANGE CORE
DELETE CORE
MAINTAIN STUDENT INFORMATION
UPDATE A&S
ADD OR CHANGE A&S COURSE
UPDATE A&S
DELETE A&S COURSE
UPDATE CORE
ADD OR CHANGE CORE COURSE
UPDATE CORE
DELETE CORE COURSE

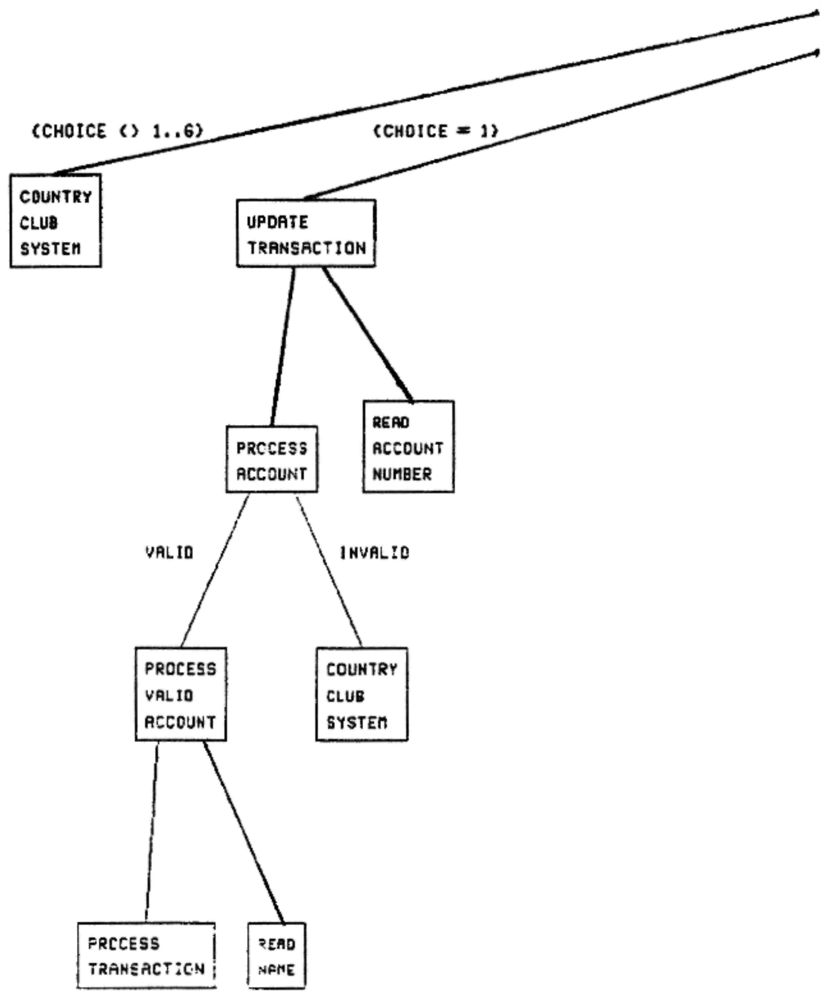

UPDATE TECH ELECT
ADVISING
PROCESS PRINTING REPORTS
ADVISING
PROCESS UPDATE TECH ELECT MENU CHOICE
DISPLAY UPDATE TECH ELECT MENU
GENERAL REPORTS
PROCESS PRINT MENU CHOICE
DISPLAY PRINT MENU
(CHOICE <> 1..3)
(CHOICE = 1)
(CHOICE = 2)
(CHOICE = 3)
(CHOICE = SCREEN)
(CHOICE = PRINTER)
UPDATE TECH ELECT
ADD OR CHANGE TECH ELECT
DELETE TECH ELECT
MAINTAIN STUDENT INFORMATION
PRINT REPORT TO SCREEN
PRINT REPORT TO PRINTER
UPDATE TECH ELECT
ADD OR CHANGE TECH ELECT COURSE
UPDATE TECH ELECT
DELETE TECH ELECT COURSE

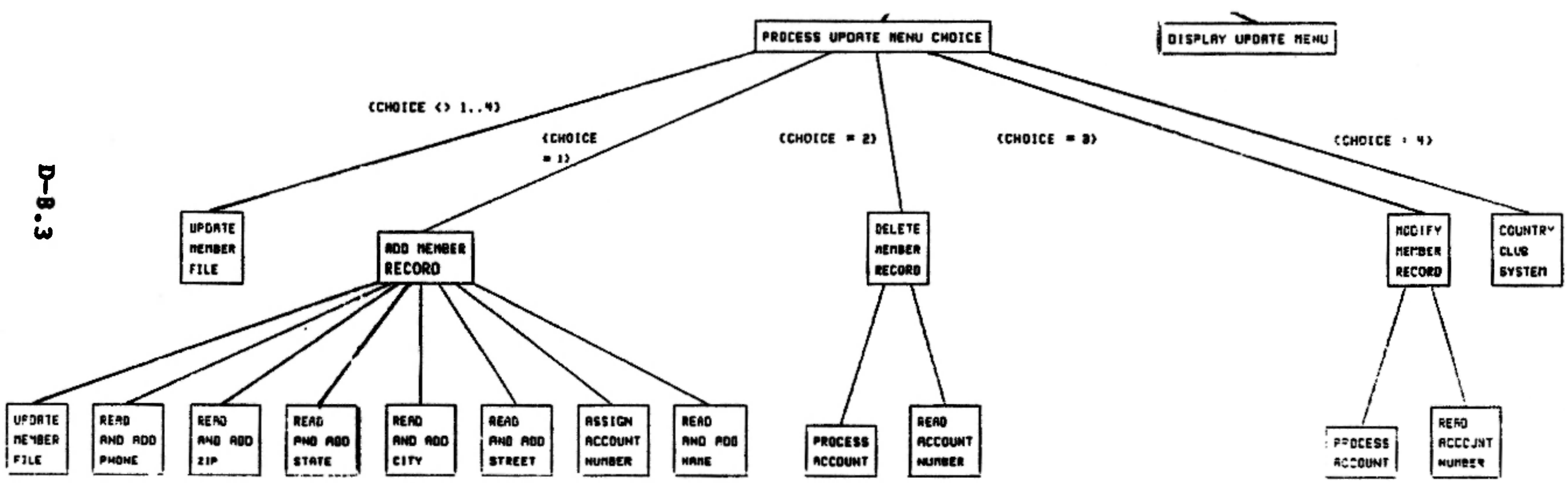

PROCESS REPORT MENU CHOICE
DISPLAY REPORT MENU
(CHOICE <> 1..7)
(CHOICE = 1)
(CHOICE = 2)
(CHOICE = 3)
(CHOICE = 4)
(CHOICE = 5)
(CHOICE = 6)
(CHOICE = 7)
REPORT MENU
PRODUCE TECH ELECT REPORT, PRINTFLAG = TRUE
PRODUCE FOUR YEAR PROGRESSION REPORT, PRINTFLAG = TRUE
PRODUCE CORE REPORT, PRINTFLAG = TRUE
PRODUCE STUDENT A&S REPORT, PRINTFLAG = TRUE
PRODUCE STUDENT CORE REPORT, PRINTFLAG = TRUE
PRODUCE STUDENT TECH ELECT REPORT, PRINTFLAG = TRUE
PRINTFLAG = FALSE

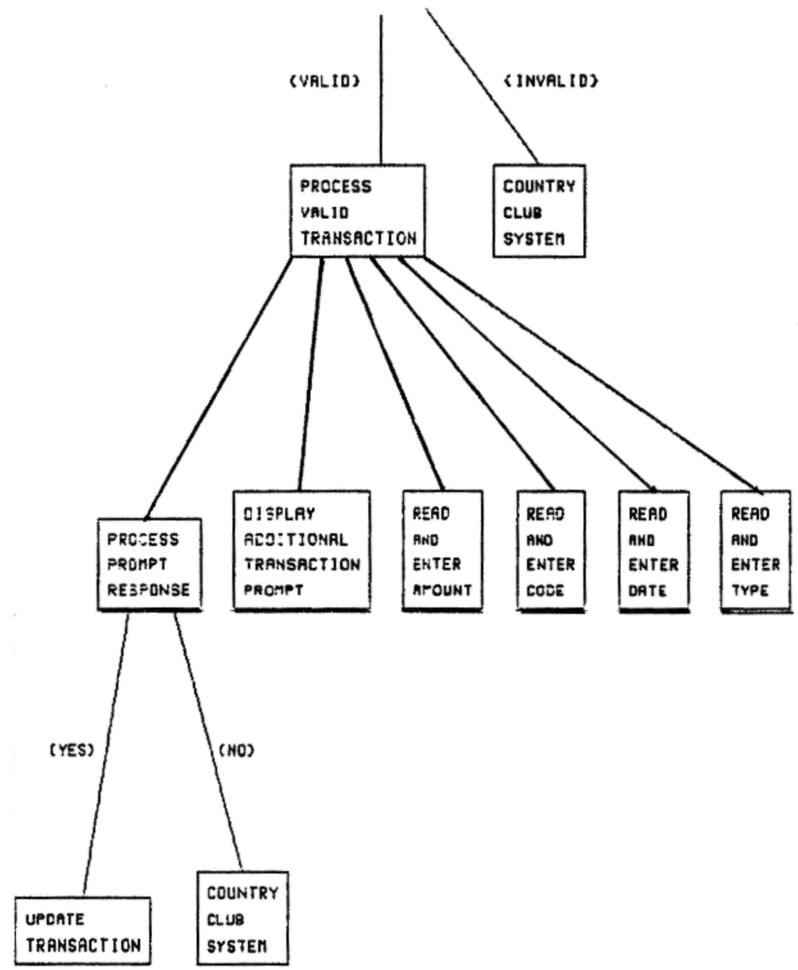
HOS Country Club

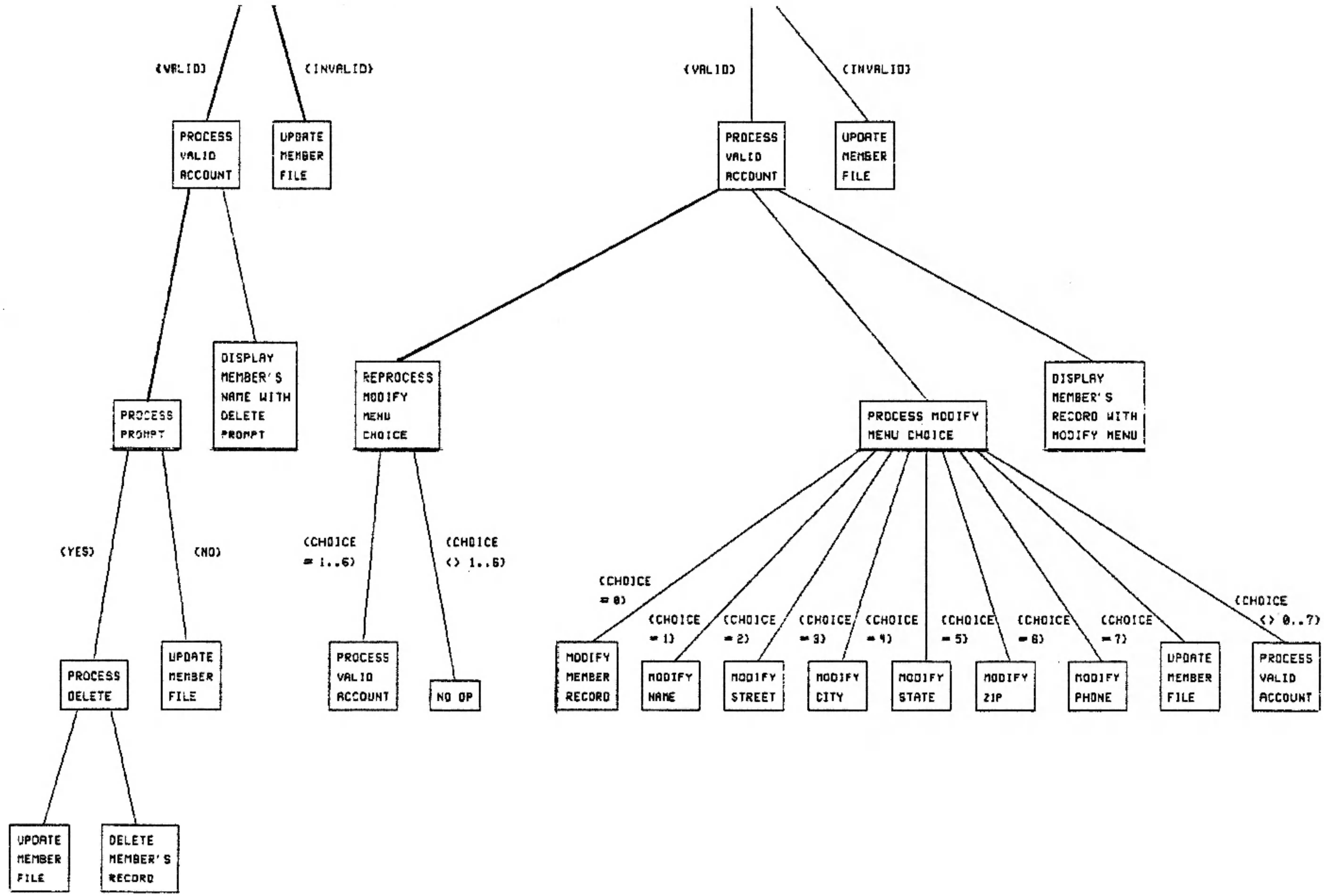



COUNTRY CLUB SYSTEM
PROCESS MAIN MENU CHOICE
DISPLAY MAIN MENU
(CHOICE = 2)
(CHOICE = 3)
(CHOICE = 4)
(CHOICE = 5)
(CHOICE = 6)
UPDATE MEMBER FILE
BILLING STATEMENTS
MEMBER LIST
SALES REPORT
EXIT PROGRAM

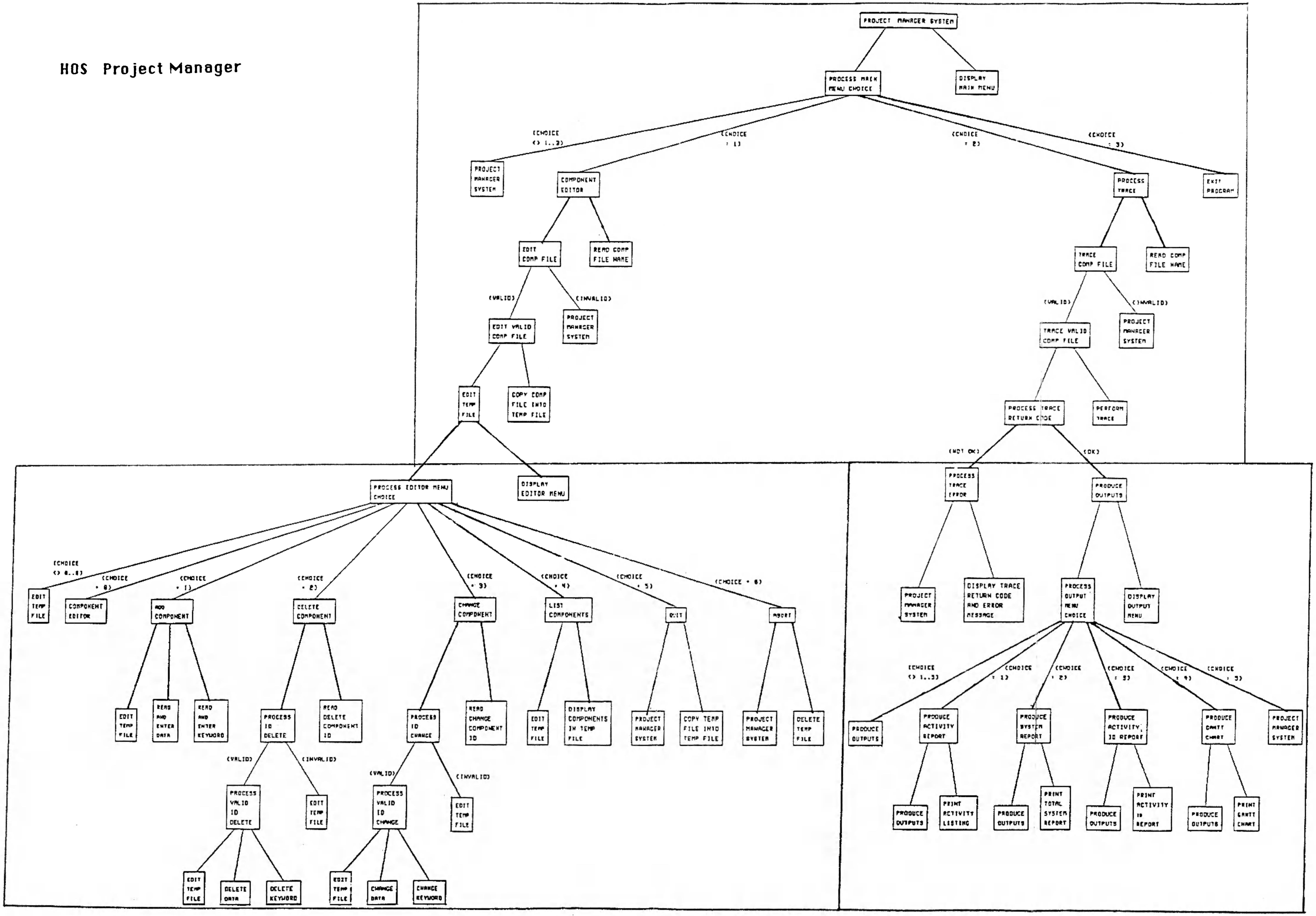

(CHOICE <> 1..6)
(CHOICE = 1)
COUNTRY CLUB SYSTEM
UPDATE TRANSACTION
PROCESS ACCOUNT
READ ACCOUNT NUMBER
VALID
INVALID
PROCESS VALID ACCOUNT
COUNTRY CLUB SYSTEM
PROCESS TRANSACTION
READ NAME

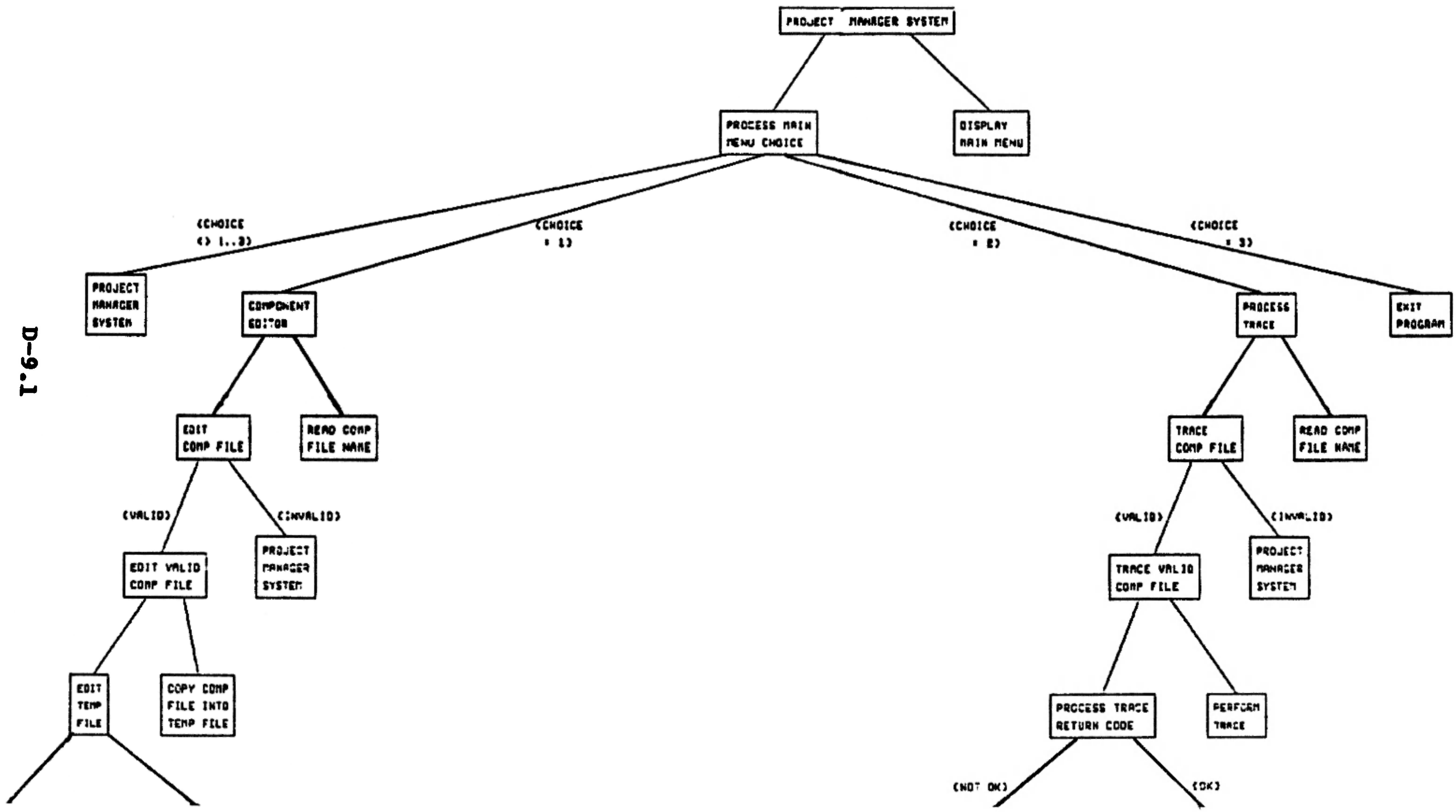

PROCESS UPDATE MENU CHOICE
DISPLAY UPDATE MENU
(CHOICE <> 1..4)
(CHOICE = 1)
(CHOICE = 2)
(CHOICE = 3)
(CHOICE = 4)
UPDATE MEMBER FILE
ADD MEMBER RECORD
DELETE MEMBER RECORD
MODIFY MEMBER RECORD
COUNTRY CLUB SYSTEM
UPDATE MEMBER FILE
READ AND ADD PHONE
READ AND ADD ZIP
READ AND ADD STATE
READ AND ADD CITY
READ AND ADD STREET
ASSIGN ACCOUNT NUMBER
READ AND ADD NAME
PROCESS ACCOUNT
READ ACCOUNT NUMBER
PROCESS ACCOUNT
READ ACCOUNT NUMBER

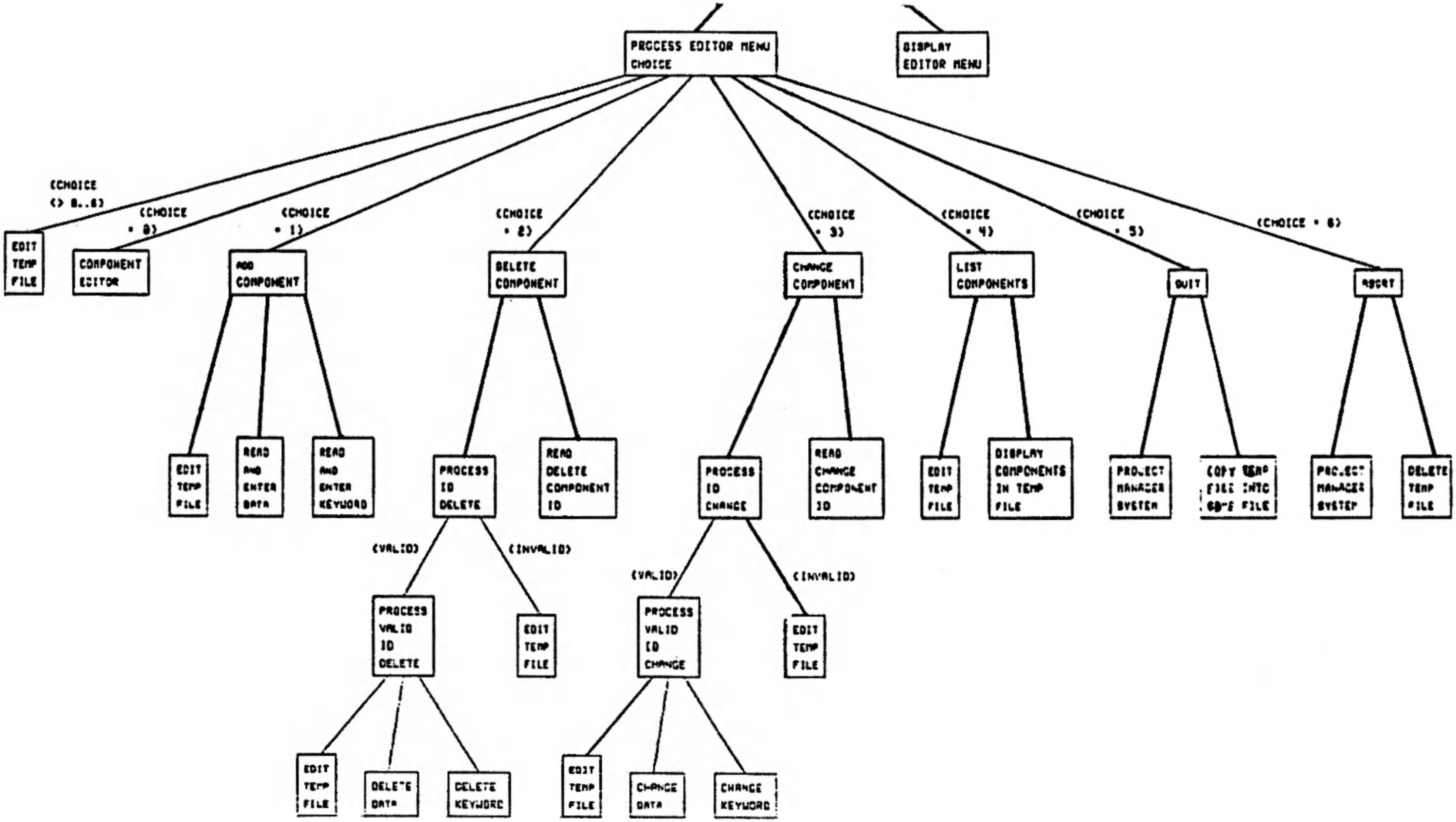

(VALID)
(INVALID)
PROCESS VALID TRANSACTION
COUNTRY CLUB SYSTEM
PROCESS PROMPT RESPONSE
DISPLAY ADDITIONAL TRANSACTION PROMPT
READ AND ENTER AMOUNT
READ AND ENTER CODE
READ AND ENTER DATE
READ AND ENTER TYPE
(YES)
(NO)
UPDATE TRANSACTION
COUNTRY CLUB SYSTEM


(VALID)
(INVALID)
PROCESS VALID ACCOUNT
UPDATE MEMBER FILE
DISPLAY MEMBER'S NAME WITH DELETE PROMPT
PROCESS PROMPT
(YES)
(NO)
PROCESS DELETE
UPDATE MEMBER FILE
UPDATE MEMBER FILE
DELETE MEMBER'S RECORD
(VALID)
(INVALID)
PROCESS VALID ACCOUNT
UPDATE MEMBER FILE
REPROCESS MODIFY MENU CHOICE
PROCESS MODIFY MENU CHOICE
DISPLAY MEMBER'S RECORD WITH MODIFY MENU
(CHOICE = 1..6)
(CHOICE <> 1..6)
PROCESS VALID ACCOUNT
NO OP
(CHOICE = 0)
(CHOICE = 1)
(CHOICE = 2)
(CHOICE = 3)
(CHOICE = 4)
(CHOICE = 5)
(CHOICE = 6)
(CHOICE = 7)
(CHOICE <> 0..7)
MODIFY MEMBER RECORD
MODIFY NAME
MODIFY STREET
MODIFY CITY
MODIFY STATE
MODIFY ZIP
MODIFY PHONE
UPDATE MEMBER FILE
PROCESS VALID ACCOUNT

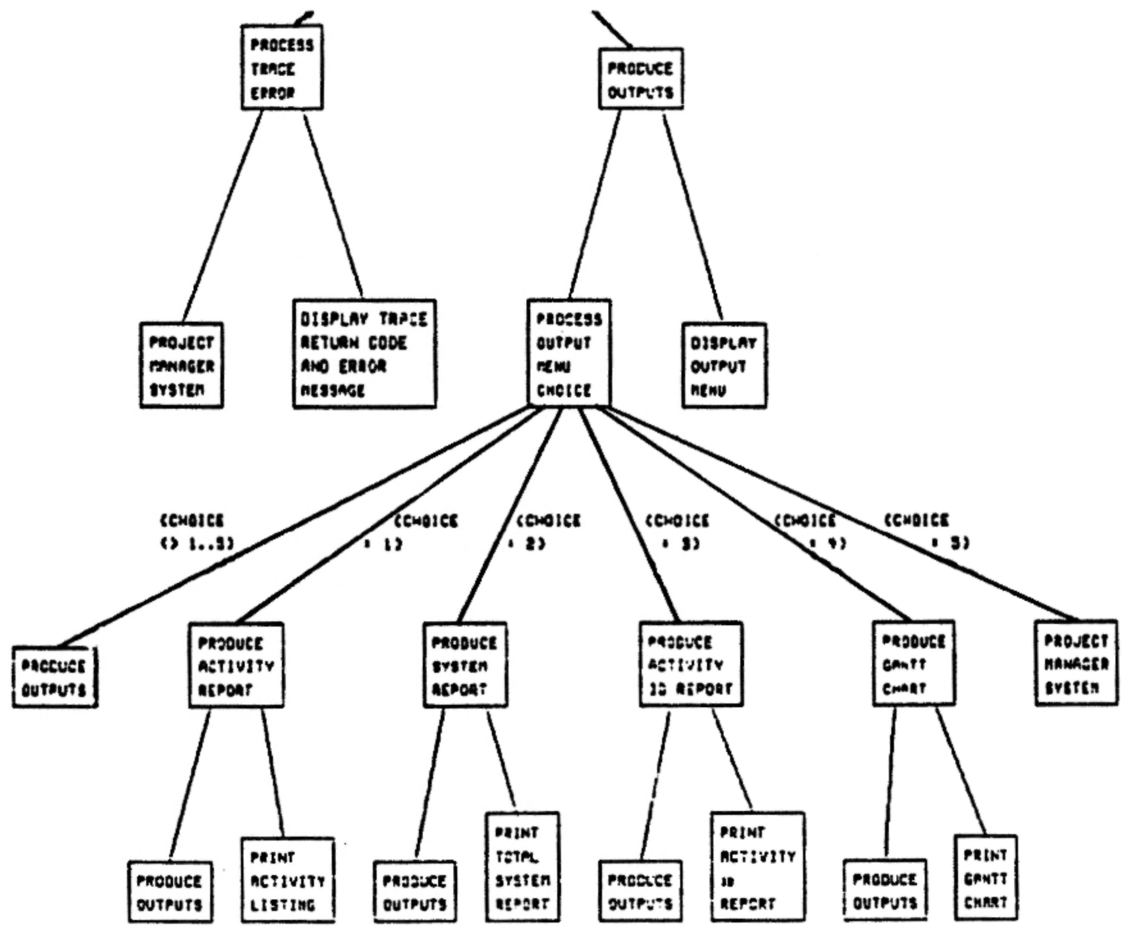
HOS Project Manager



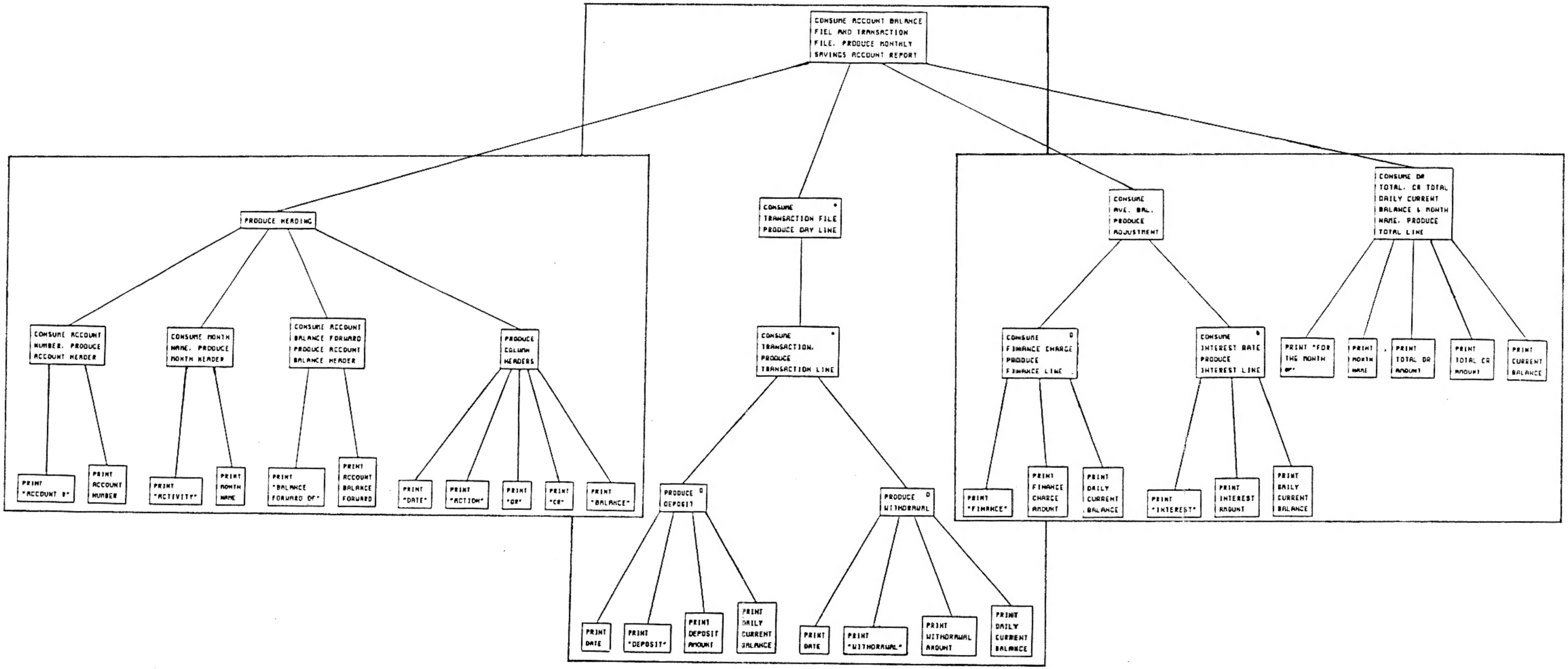

PROJECT MANAGER SYSTEM
PROCESS MAIN MENU CHOICE
DISPLAY MAIN MENU
(CHOICE <> 1..3)
(CHOICE = 1)
(CHOICE = 2)
(CHOICE = 3)
PROJECT MANAGER SYSTEM
COMPONENT EDITOR
PROCESS TRACE
EXIT PROGRAM
EDIT COMP FILE
READ COMP FILE NAME
TRACE COMP FILE
READ COMP FILE NAME
(VALID)
(INVALID)
(VALID)
(INVALID)
EDIT VALID COMP FILE
PROJECT MANAGER SYSTEM
TRACE VALID COMP FILE
PROJECT MANAGER SYSTEM
EDIT TEMP FILE
COPY COMP FILE INTO TEMP FILE
PROCESS TRACE RETURN CODE
PERFORM TRACE
(NOT OK)
(OK)

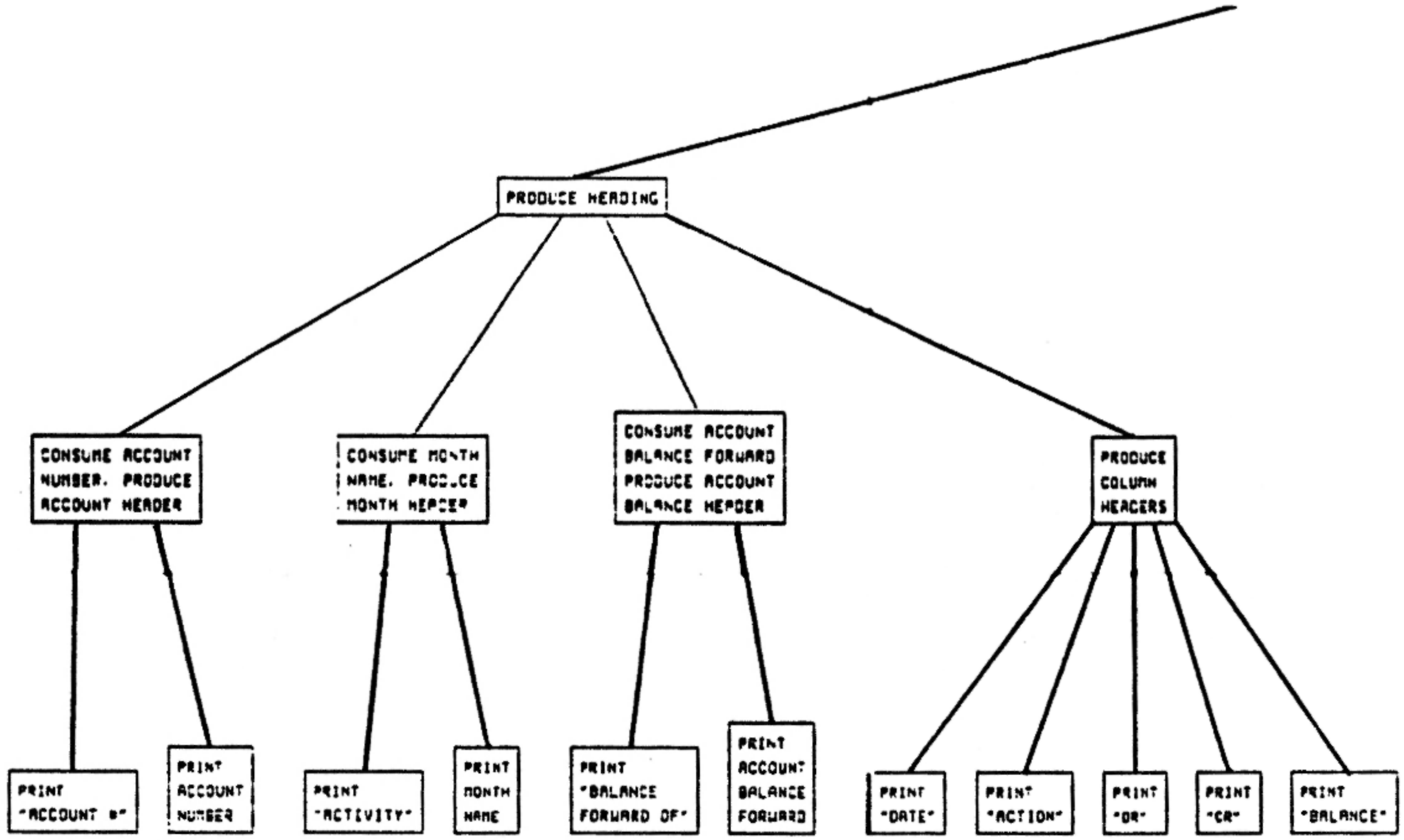


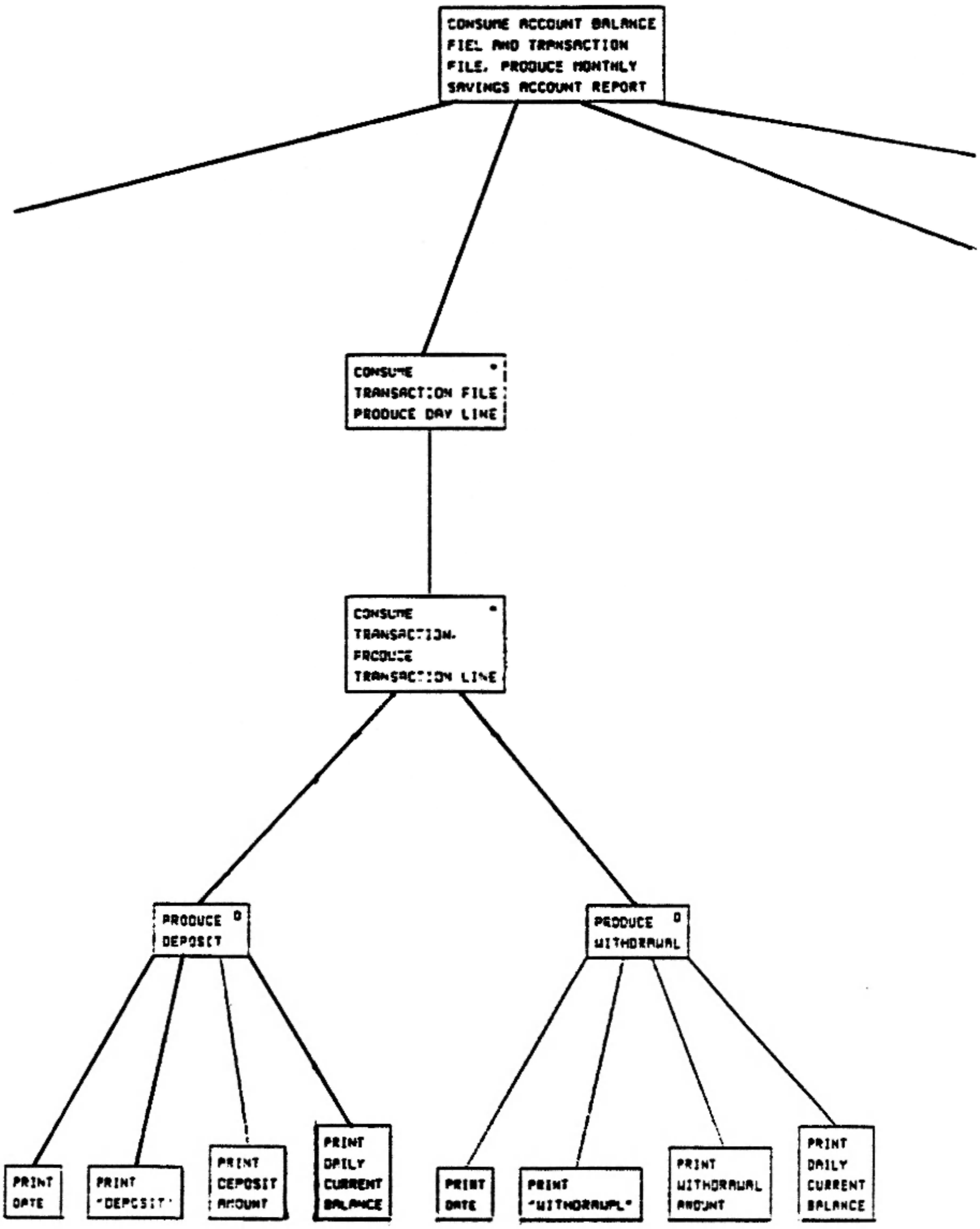
PROCESS EDITOR MENU CHOICE
DISPLAY EDITOR MENU
(CHOICE <> 0..6)
EDIT TEMP FILE
(CHOICE = 0)
COMPONENT EDITOR
(CHOICE = 1)
ADD COMPONENT
EDIT TEMP FILE
READ AND ENTER DATA
READ AND ENTER KEYWORD
(CHOICE = 2)
DELETE COMPONENT
PROCESS ID DELETE
READ DELETE COMPONENT ID
(VALID)
(INVALID)
PROCESS VALID ID DELETE
EDIT TEMP FILE
EDIT TEMP FILE
DELETE DATA
DELETE KEYWORD
(CHOICE = 3)
CHANGE COMPONENT
PROCESS ID CHANGE
READ CHANGE COMPONENT ID
(VALID)
(INVALID)
PROCESS VALID ID CHANGE
EDIT TEMP FILE
EDIT TEMP FILE
CHANGE DATA
CHANGE KEYWORD
(CHOICE = 4)
LIST COMPONENTS
EDIT TEMP FILE
DISPLAY COMPONENTS IN TEMP FILE
(CHOICE = 5)
QUIT
PROJECT MANAGER SYSTEM
(CHOICE = 6)
ABORT
PROJECT MANAGER SYSTEM
DELETE TEMP FILE

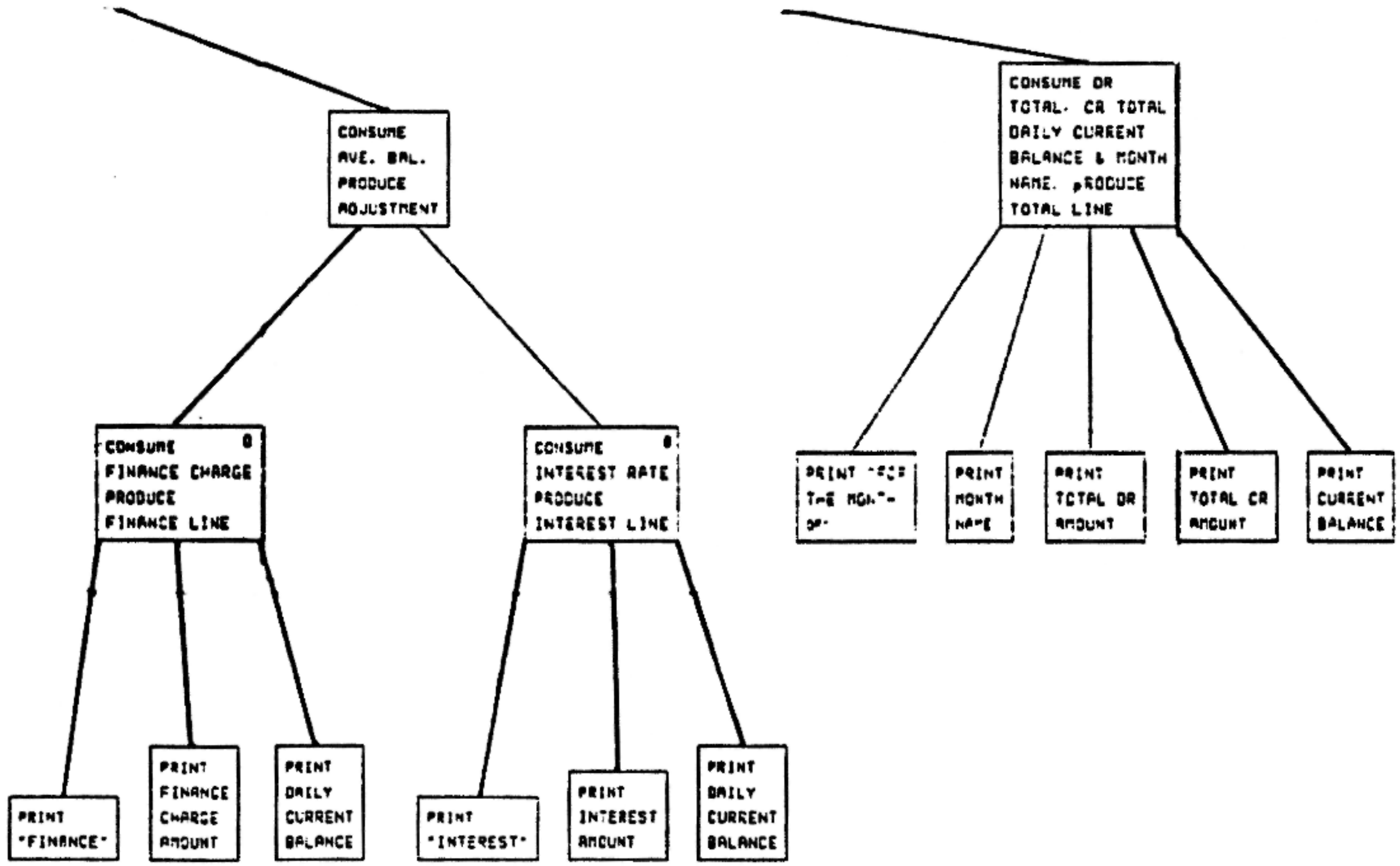

PROCESS TRACE ERROR
PRODUCE OUTPUTS
PROJECT MANAGER SYSTEM
DISPLAY TRACE RETURN CODE AND ERROR MESSAGE
PROCESS OUTPUT MENU CHOICE
DISPLAY OUTPUT MENU
(CHOICE <> 1..5)
(CHOICE = 1)
(CHOICE = 2)
(CHOICE = 3)
(CHOICE = 4)
(CHOICE = 5)
PRODUCE OUTPUTS
PRODUCE ACTIVITY REPORT
PRODUCE SYSTEM REPORT
PRODUCE ACTIVITY ID REPORT
PRODUCE GANTT CHART
PROJECT MANAGER SYSTEM
PRODUCE OUTPUTS
PRINT ACTIVITY LISTING
PRODUCE OUTPUTS
PRINT TOTAL SYSTEM REPORT
PRODUCE OUTPUTS
PRINT ACTIVITY ID REPORT
PRODUCE OUTPUTS
PRINT GANTT CHART

Jackson Savings Account

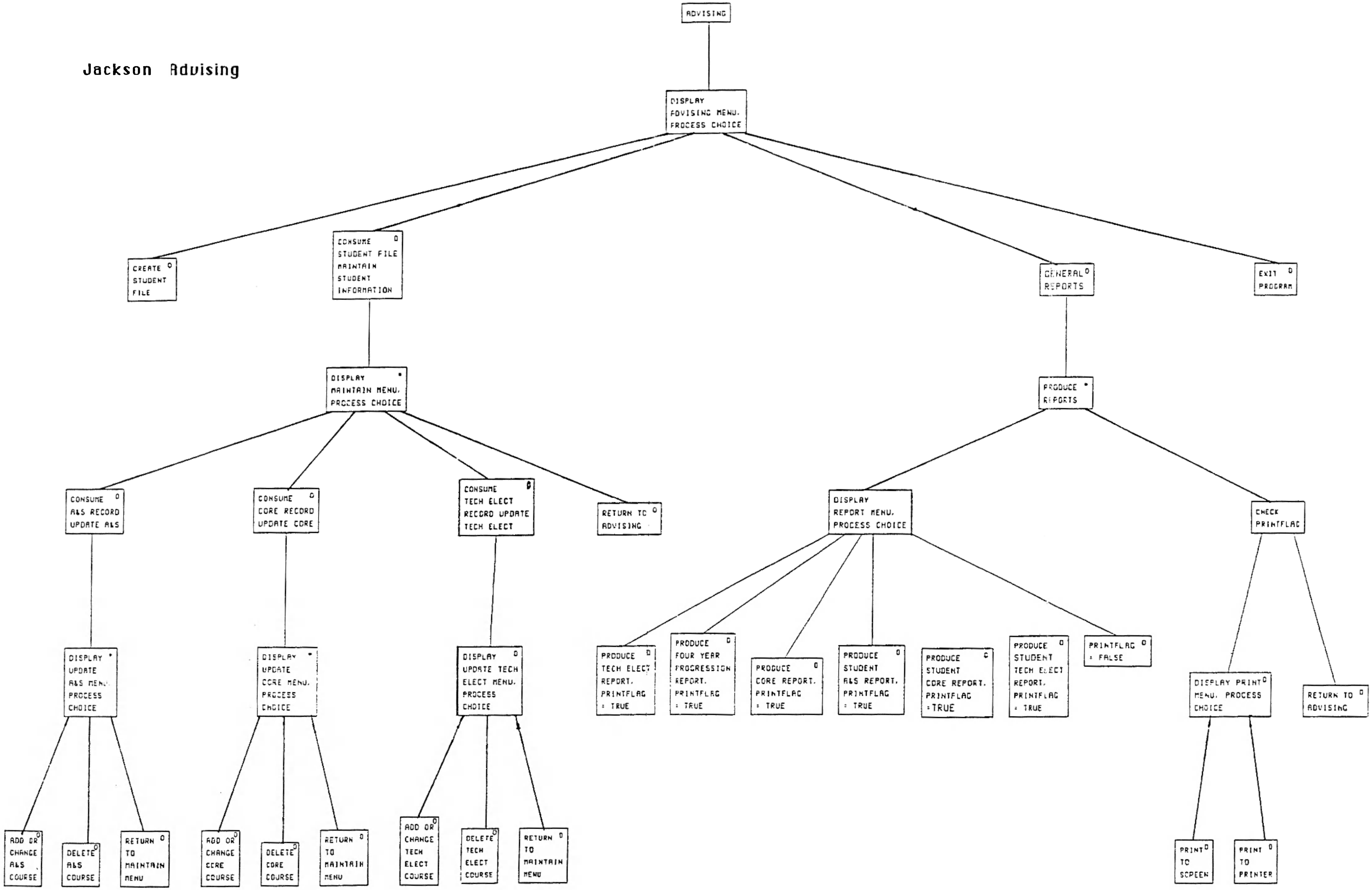



PRODUCE HEADING
CONSUME ACCOUNT NUMBER, PRODUCE ACCOUNT HEADER
CONSUME MONTH NAME, PRODUCE MONTH HEADER
CONSUME ACCOUNT BALANCE FORWARD PRODUCE ACCOUNT BALANCE HEADER
PRODUCE COLUMN HEADERS
PRINT "ACCOUNT #"
PRINT ACCOUNT NUMBER
PRINT "ACTIVITY"
PRINT MONTH NAME
PRINT "BALANCE FORWARD OF"
PRINT ACCOUNT BALANCE FORWARD
PRINT "DATE"
PRINT "ACTION"
PRINT "DR"
PRINT "CR"
PRINT "BALANCE"

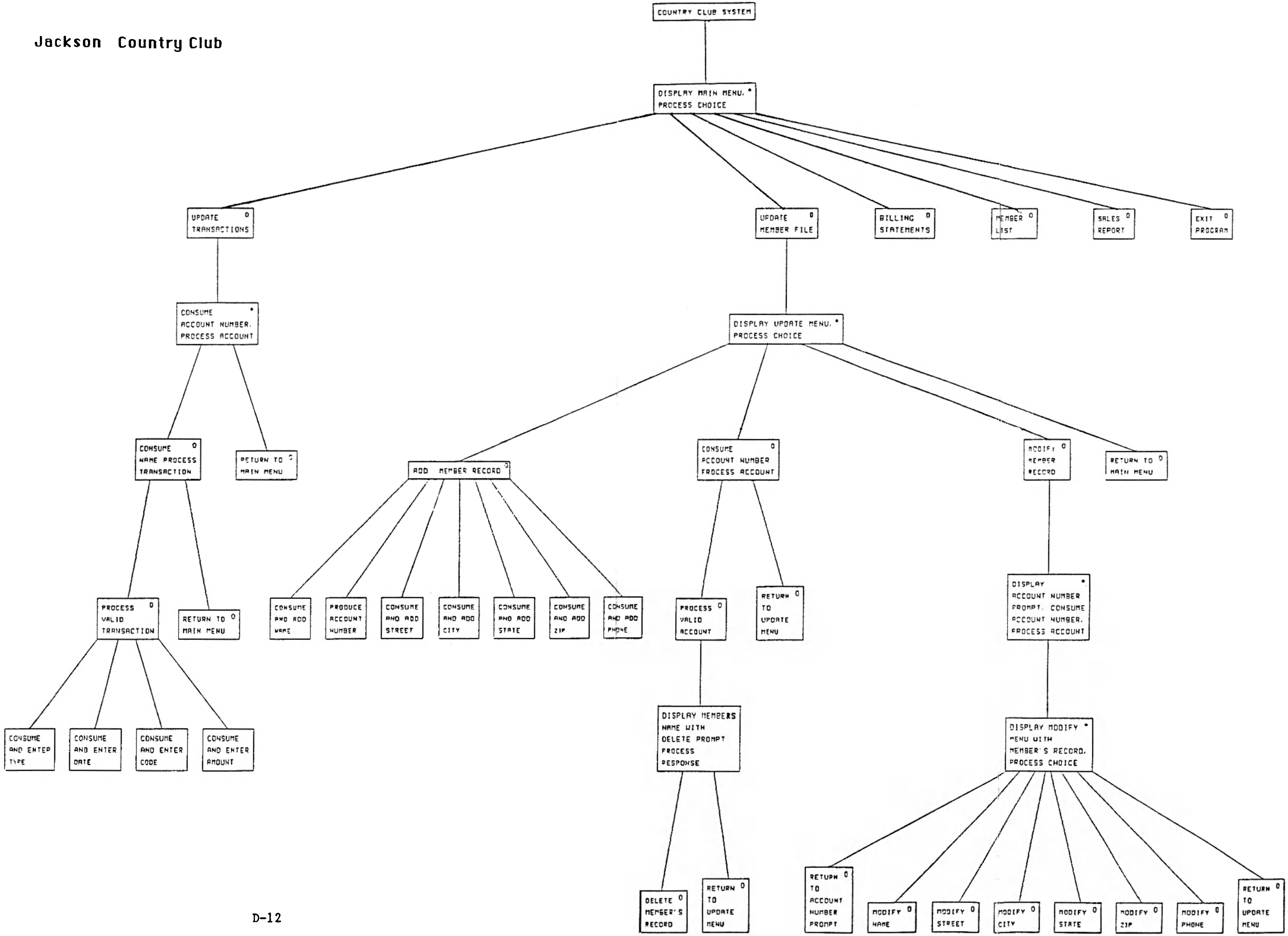

CONSUME ACCOUNT BALANCE FIEL AND TRANSACTION FILE, PRODUCE MONTHLY SAVINGS ACCOUNT REPORT
CONSUME TRANSACTION FILE PRODUCE DAY LINE
*
CONSUME TRANSACTION, PRODUCE TRANSACTION LINE
*
PRODUCE DEPOSIT
O
PRODUCE WITHDRAWAL
O
PRINT DATE
PRINT "DEPOSIT"
PRINT DEPOSIT AMOUNT
PRINT DAILY CURRENT BALANCE
PRINT DATE
PRINT "WITHDRAWAL"
PRINT WITHDRAWAL AMOUNT
PRINT DAILY CURRENT BALANCE


CONSUME AVE. BAL. PRODUCE ADJUSTMENT
CONSUME FINANCE CHARGE PRODUCE FINANCE LINE
CONSUME INTEREST RATE PRODUCE INTEREST LINE
PRINT "FINANCE"
PRINT FINANCE CHARGE AMOUNT
PRINT DAILY CURRENT BALANCE
PRINT "INTEREST"
PRINT INTEREST AMOUNT
PRINT DAILY CURRENT BALANCE
CONSUME DR TOTAL, CR TOTAL DAILY CURRENT BALANCE & MONTH NAME. PRODUCE TOTAL LINE
PRINT MONTH NAME
PRINT TOTAL DR AMOUNT
PRINT TOTAL CR AMOUNT
PRINT CURRENT BALANCE

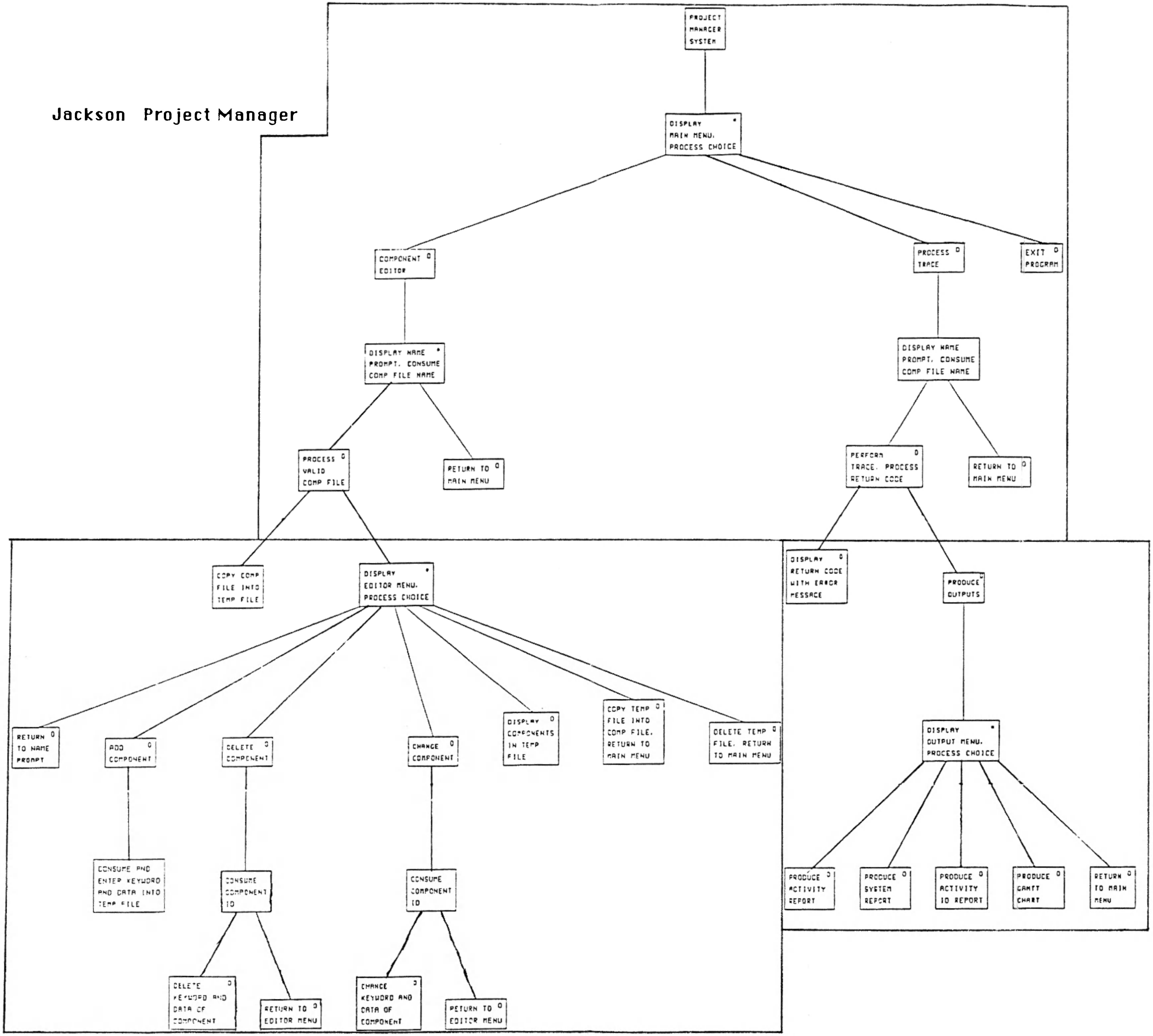
Jackson Advising

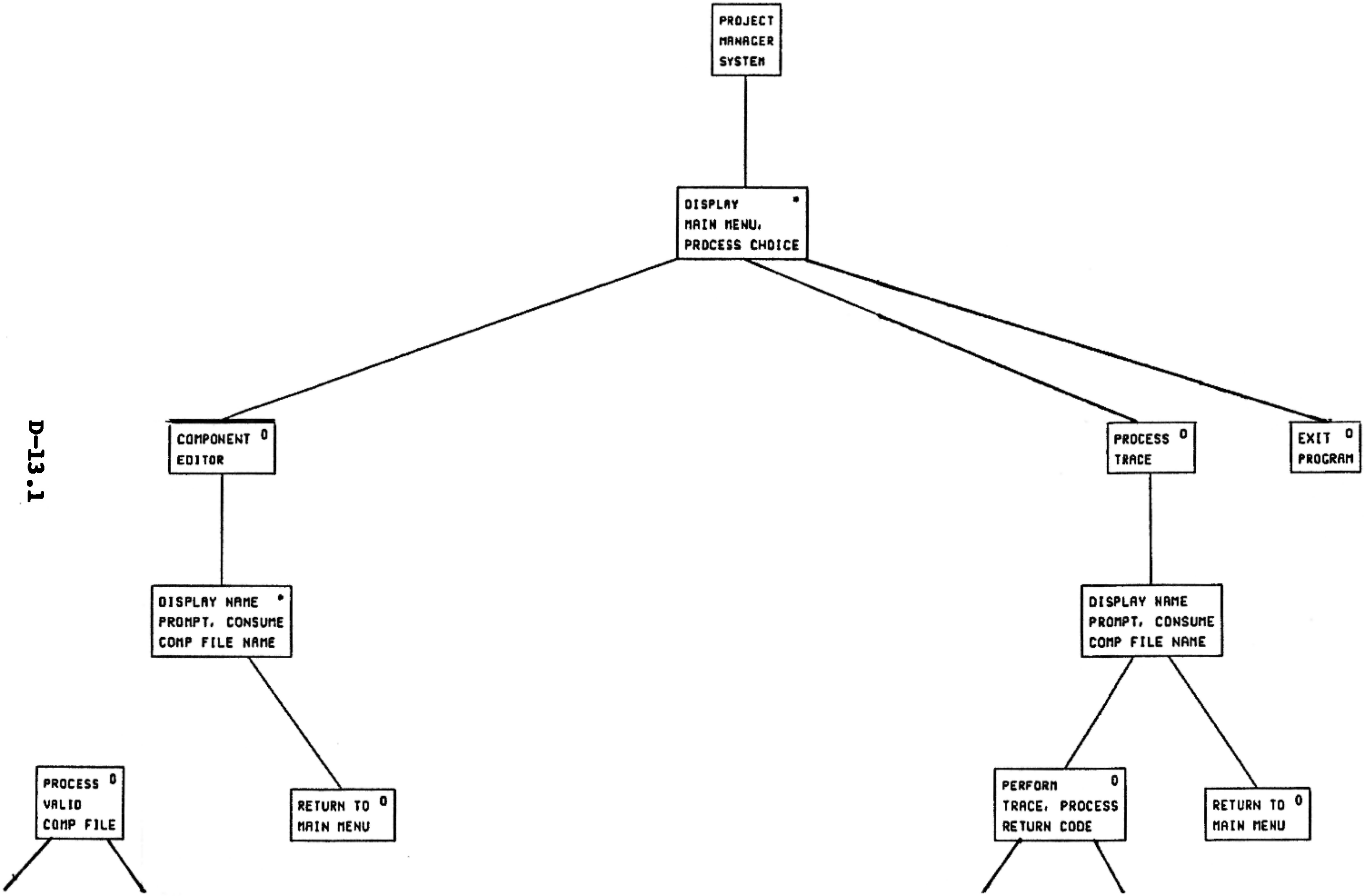


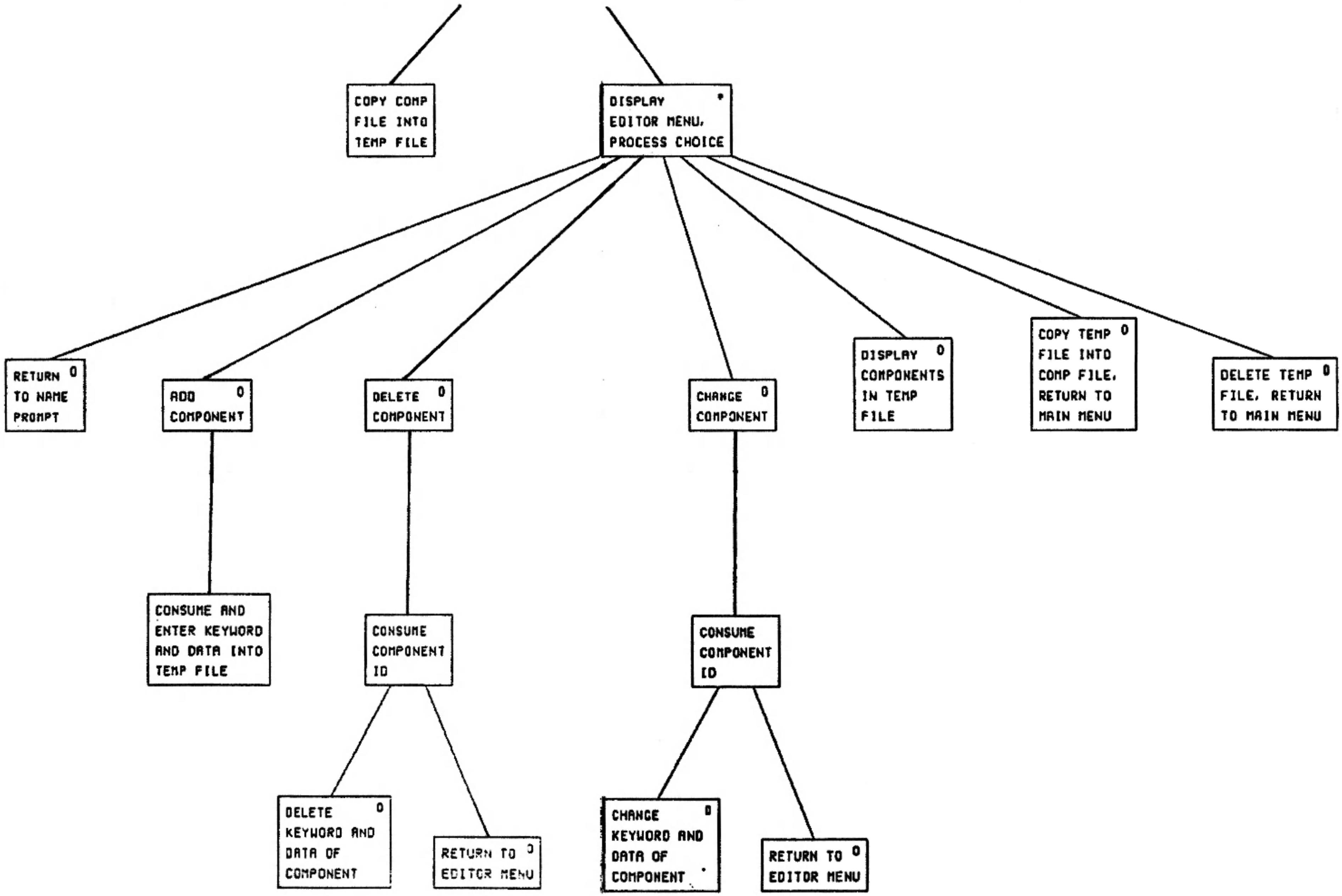
Jackson Country Club

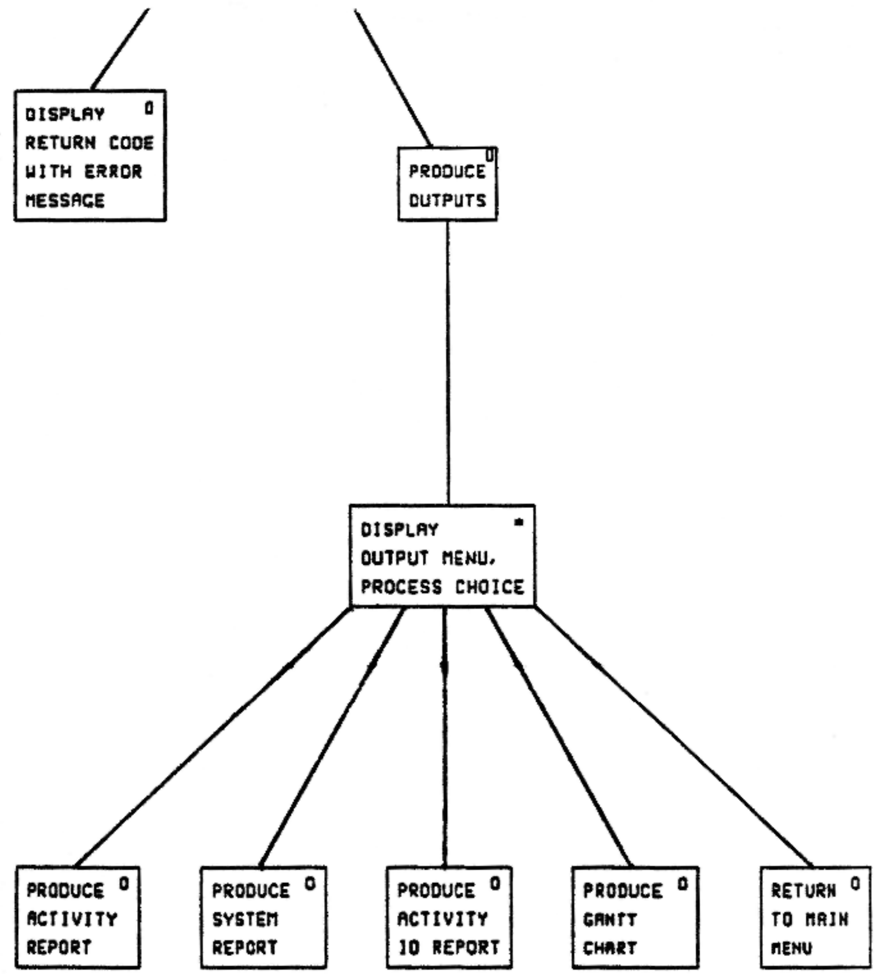


Jackson Project Manager




PROJECT MANAGER SYSTEM
DISPLAY MAIN MENU, PROCESS CHOICE *
COMPONENT EDITOR 0
PROCESS TRACE 0
EXIT PROGRAM 0
DISPLAY NAME PROMPT, CONSUME COMP FILE NAME *
DISPLAY NAME PROMPT, CONSUME COMP FILE NAME
PROCESS VALID COMP FILE 0
RETURN TO MAIN MENU 0
PERFORM TRACE, PROCESS RETURN CODE 0
RETURN TO MAIN MENU 0


COPY COMP FILE INTO TEMP FILE
DISPLAY EDITOR MENU, PROCESS CHOICE
RETURN TO NAME PROMPT 0
ADD COMPONENT 0
DELETE COMPONENT 0
CHANGE COMPONENT 0
DISPLAY COMPONENTS IN TEMP FILE 0
COPY TEMP FILE INTO COMP FILE, RETURN TO MAIN MENU 0
DELETE TEMP FILE, RETURN TO MAIN MENU 0
CONSUME AND ENTER KEYWORD AND DATA INTO TEMP FILE
CONSUME COMPONENT ID
CONSUME COMPONENT ID
DELETE KEYWORD AND DATA OF COMPONENT 0
RETURN TO EDITOR MENU 0
CHANGE KEYWORD AND DATA OF COMPONENT 0
RETURN TO EDITOR MENU 0


DISPLAY RETURN CODE WITH ERROR MESSAGE
PRODUCE OUTPUTS
DISPLAY OUTPUT MENU, PROCESS CHOICE
PRODUCE ACTIVITY REPORT
PRODUCE SYSTEM REPORT
PRODUCE ACTIVITY IO REPORT
PRODUCE GANTT CHART
RETURN TO MAIN MENU

Warnier-Orr Savings Account

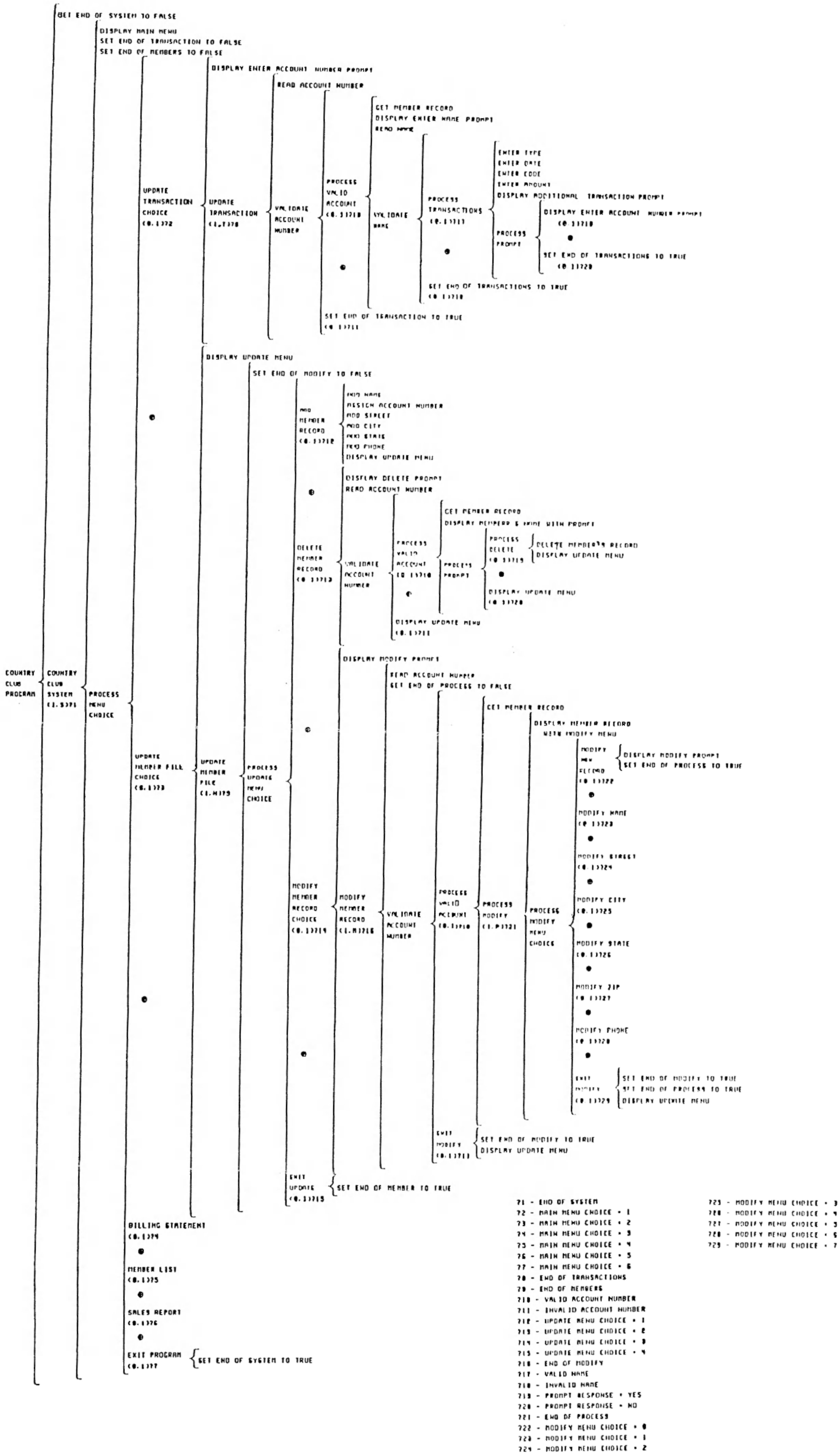
```
MONTHLY SAVINGS ACCOUNT REPORT
    OPEN INPUT: TRANSACTION FILE:
                ACCOUNT BALANCE FILE
    GET FIRST TRANSACTION FILE
    HEADING
        PRINT "ACCOUNT #" ACCOUNT NUMBER
        GET ACCOUNT BALANCE FORWARD
        MOVE ACCOUNT BALANCE FORWARD
             TO DAILY
        GET INTEREST RATE
        PRINT "ACTIVITY"
              MONTH NAME
              "BALANCE FORWARD OF"
              DAILY
              "DATE" "ACTION" "DR" "CR" "BALANCE"
        SET END OF DAYS TO FALSE
    DAY (1,D)?1
        PRINT DATE
        SUM OF BALANCES
            SUM (0,1)?2
                NUMBER OF DAYS = NEW DATE - OLD DATE
                SUMBAL = OLD SUMBAL + (OLD DAILY * NUMBER OF DAYS)
                OLD DATE = NEW DATE
            ●
            UPDATE (0,1)?3
                SUMBAL = OLD SUMBAL
                OLD DATE = NEW DATE
        TRANSACTION
            DEPOSIT (0,1)?4
                ADD DEPOSIT AMOUNT TO DAILY
                PRINT "DEPOSIT" DEPOSIT AMOUNT
                ADD DEPOSIT AMOUNT TO DR TOTAL
            ●
            WITHDRAWAL (0,1)?5
                SUBTRACT WITHDRAWAL AMOUNT FROM DAILY
                PRINT "WITHDRAWAL" WITHDRAWAL AMOUNT
                ADD WITHDRAWAL AMOUNT TO CR TOTAL
        PRINT DAILY
    MONTH END
        CALCULATE AVERAGE BALANCE
            NUMBER OF DAYS = (LAST DAY + 1) - OLD DATE
            SUMBAL = OLD SUMBAL + (OLD DAILY * NUMBER OF DAYS)
            AVEBAL = SUMBAL / NUMBER OF DAYS IN MONTH
        ADJUSTMENTS
            FINANCE (0,1)?6
                SUBTRACT FINANCE CHARGE FROM MONTHLY BALANCE
                PRINT "FINANCE CHARGE" FINANCE CHARGE AMOUNT
                ADD FINANCE CHARGE TO CR TOTAL
            ●
            INTEREST (0,1)?7
                MULTIPLY AVERAGE BALANCE BY INTEREST RATE
                ADD INTEREST AMOUNT TO MONTHLY BALANCE
                PRINT "INTEREST" INTEREST AMOUNT
                ADD INTEREST AMOUNT TO DR TOTAL
        PRINT MONTHLY BALANCE
    TOTALS
        PRINT "FOR THE MONTH OF"
              MONTH NAME
              DR TOTAL
              CR TOTAL
              MONTHLY BALANCE
    CLOSE TRANSACTION FILE
          ACCOUNT BALANCE FILE
```

```
?1 - END OF DAYS
?2 - NEW DATE <> OLD DATE
?3 - NEW DATE = OLD DATE
?4 - DEPOSIT TRANSACTION
?5 - WITHDRAWAL TRANSACTION
?6 - FINANCE - AVERAGE BALANCE < $100.00
?7 - INTEREST - AVERAGE BALANCE >= $100.00
```

- STUDENT ADVISORY PROGRAM
  - SET END OF ADVISING TO FALSE
  - ADVISING (1,A)?1
    - DISPLAY ADVISING MENU
    - SET END OF MAINTAIN TO FALSE
    - SET END OF REPORTS TO FALSE
    - PROCESS ADVISING MENU CHOICE
      - OBTAIN STUDENT INFORMATION CHOICE (0,1)?2
        - CREATE STUDENT FILES
      - MAINTAIN STUDENT INFORMATION CHOICE (0,1)?3
        - GET STUDENT FILE
        - MAINTAIN STUDENT INFORMATION (1,A)?6
          - DISPLAY MAINTAIN MENU
          - SET END OF UPDATE TO FALSE
          - PROCESS MAINTAIN MENU CHOICE
            - UPDATE ALS CHOICE (0,1)?8
              - GET ALS RECORD OF STUDENT FILE
              - UPDATE ALS (1,U)?14
                - DISPLAY UPDATE MENU
                - PROCESS UPDATE MENU CHOICE
                  - ADD OR CHANGE ALS COURSE (0,1)?24
                  - DELETE ALS COURSE (0,1)?25
                  - SET END OF UPDATE TO TRUE (0,1)?26
            - UPDATE CORE CHOICE (0,1)?9
              - GET CORE RECORD OF STUDENT FILE
              - UPDATE CORE (1,U)?14
                - DISPLAY UPDATE MENU
                - PROCESS UPDATE MENU CHOICE
                  - ADD OR CHANGE CORE COURSE (0,1)?24
                  - DELETE CORE COURSE (0,1)?25
                  - SET END OF UPDATE TO TRUE (0,1)?26
            - UPDATE TECH ELECT CHOICE (0,1)?10
              - GET TECH ELECT RECORD OF STUDENT FILE
              - UPDATE TECH ELECT (1,U)?14
                - DISPLAY UPDATE MENU
                - PROCESS UPDATE MENU CHOICE
                  - ADD OR CHANGE TECH ELECT COURSE (0,1)?24
                  - DELETE TECH ELECT COURSE (0,1)?25
                  - SET END OF UPDATE TO TRUE (0,1)?26
            - EXIT MAINTAIN CHOICE (0,1)?11
              - SET END OF MAINTAIN TO TRUE
      - GENERAL REPORTS CHOICE (0,1)?4
        - GENERAL REPORTS (1,A)?7
          - REPORT MENU
            - DISPLAY REPORT MENU
            - PROCESS REPORT MENU CHOICE
              - TECH ELECT CHOICE (0,1)?15
                - PRODUCE TECH ELECT REPORT
                - SET PRINTFLAG TO TRUE
              - FOUR YEAR PROGRESSION CHOICE (0,1)?16
                - PRODUCE FOUR YEAR PROGRESSION REPORT
                - SET PRINTFLAG TO TRUE
              - CORE CHOICE (0,1)?17
                - PRODUCE CORE REPORT
                - SET PRINTFLAG TO TRUE
              - STUDENT ALS CHOICE (0,1)?18
                - PRODUCE STUDENT ALS REPORT
                - SET PRINTFLAG TO TRUE
              - STUDENT CORE CHOICE (0,1)?19
                - PRODUCE STUDENT CORE REPORT
                - SET PRINTFLAG TO TRUE
              - STUDENT TECH ELECT CHOICE (0,1)?20
                - PRODUCE STUDENT TECH ELECT REPORT
                - SET PRINTFLAG TO TRUE
              - EXIT REPORT CHOICE (0,1)?21
                - SET PRINTFLAG TO TRUE
          - CHECK PRINTFLAG
            - PROCESS PRINTING (0,1)?12
              - DISPLAY PRINT
              - PROCESS PRINT MENU CHOICE
                - PRINT TO SCREEN (0,1)?22
                - PRINT TO PRINTER (0,1)?23
            - NO PRINT (0,1)?13
              - SET END OF REPORTS TO TRUE
      - EXIT PROGRAM CHOICE (0,1)?5
        - SET END OF ADVISING TO TRUE
  - .END

?1 END OF ADVISING
?2 ADVISING MENU CHOICE = 1
?3 ADVISING MENU CHOICE = 2
?4 ADVISING MENU CHOICE = 3
?5 ADVISING MENU CHOICE = 4
?6 END OF MAINTAIN
?7 END OF REPORTS
?8 MAINTAIN MENU CHOICE = 1
?9 MAINTAIN MENU CHOICE = 2
?10 MAINTAIN MENU CHOICE = 3
?11 MAINTAIN MENU CHOICE = 4
?12 PRINTFLAG = TRUE
?13 PRINTFLAG = FALSE
?14 END OF UPDATE
?15 REPORT MENU CHOICE = 1
?16 REPORT MENU CHOICE = 2
?17 REPORT MENU CHOICE = 3
?18 REPORT MENU CHOICE = 4
?19 REPORT MENU CHOICE = 5
?20 REPORT MENU CHOICE = 6
?21 REPORT MENU CHOICE = 7
?22 PRINT MENU CHOICE = 1
?23 PRINT MENU CHOICE = 2
?24 UPDATE MENU CHOICE = 1
?25 UPDATE MENU CHOICE = 2
?26 UPDATE MENU CHOICE = 3

?1 END OF ADVISING
?2 ADVISING MENU CHOICE = 1
?3 ADVISING MENU CHOICE = 2
?4 ADVISING MENU CHOICE = 3
?5 ADVISING MENU CHOICE = 4
?6 END OF MAINTAIN
?7 END OF REPORTS
?8 MAINTAIN MENU CHOICE = 1
?9 MAINTAIN MENU CHOICE = 2
?10 MAINTAIN MENU CHOICE = 3
?11 MAINTAIN MENU CHOICE = 4
?12 PRINTFLAG = TRUE
?13 PRINTFLAG = FALSE
?14 END OF UPDATE
?15 REPORT MENU CHOICE = 1
?16 REPORT MENU CHOICE = 2
?17 REPORT MENU CHOICE = 3
?18 REPORT MENU CHOICE = 4
?19 REPORT MENU CHOICE = 5
?20 REPORT MENU CHOICE = 6
?21 REPORT MENU CHOICE = 7
?22 PRINT MENU CHOICE = 1
?23 PRINT MENU CHOICE = 2
?24 UPDATE MENU CHOICE = 1
?25 UPDATE MENU CHOICE = 2
?26 UPDATE MENU CHOICE = 3


COUNTRY CLUB PROGRAM
COUNTRY CLUB SYSTEM (1, S?1)
SET END OF SYSTEM TO FALSE
PROCESS MENU CHOICE
DISPLAY MAIN MENU
SET END OF TRANSACTION TO FALSE
SET END OF MEMBERS TO FALSE
UPDATE TRANSACTION CHOICE (0, 1?2)
UPDATE TRANSACTION (1, T?8)
DISPLAY ENTER ACCOUNT NUMBER PROMPT
READ ACCOUNT NUMBER
VALIDATE ACCOUNT NUMBER
PROCESS VALID ACCOUNT (0, 1?10)
GET MEMBER RECORD
DISPLAY ENTER NAME PROMPT
READ NAME
VALIDATE NAME
PROCESS TRANSACTIONS (0, 1?17)
ENTER TYPE
ENTER DATE
ENTER CODE
ENTER AMOUNT
DISPLAY ADDITIONAL TRANSACTION PROMPT
PROCESS PROMPT
DISPLAY ENTER ACCOUNT NUMBER PROMPT (0, 1?19)
SET END OF TRANSACTIONS TO TRUE (0, 1?20)
SET END OF TRANSACTIONS TO TRUE (0, 1?18)
SET END OF TRANSACTION TO TRUE (0, 1?11)
UPDATE MEMBER FILE CHOICE (0, 1?3)
UPDATE MEMBER FILE (1, M?9)
DISPLAY UPDATE MENU
SET END OF MODIFY TO FALSE
PROCESS UPDATE MENU CHOICE
ADD MEMBER RECORD (0, 1?12)
ADD NAME
ASSIGN ACCOUNT NUMBER
ADD STREET
ADD CITY
ADD STATE
ADD PHONE
DISPLAY UPDATE MENU
DELETE MEMBER RECORD (0, 1?13)
DISPLAY DELETE PROMPT
READ ACCOUNT NUMBER
VALIDATE ACCOUNT NUMBER
PROCESS VALID ACCOUNT (0, 1?10)
GET MEMBER RECORD
DISPLAY MEMBER'S NAME WITH PROMPT
PROCESS PROMPT
PROCESS DELETE (0, 1?19)
DELETE MEMBER'S RECORD
DISPLAY UPDATE MENU
DISPLAY UPDATE MENU (0, 1?20)
DISPLAY UPDATE MENU (0, 1?11)
MODIFY MEMBER RECORD CHOICE (0, 1?14)
MODIFY MEMBER RECORD (1, M?16)
DISPLAY MODIFY PROMPT
VALIDATE ACCOUNT NUMBER
READ ACCOUNT NUMBER
SET END OF PROCESS TO FALSE
PROCESS VALID ACCOUNT (0, 1?10)
GET MEMBER RECORD
PROCESS MODIFY (1, P?21)
DISPLAY MEMBER RECORD WITH MODIFY MENU
PROCESS MODIFY MENU CHOICE
MODIFY NEW RECORD (0, 1?22)
DISPLAY MODIFY PROMPT
SET END OF PROCESS TO TRUE
MODIFY NAME (0, 1?23)
MODIFY STREET (0, 1?24)
MODIFY CITY (0, 1?25)
MODIFY STATE (0, 1?26)
MODIFY ZIP (0, 1?27)
MODIFY PHONE (0, 1?28)
EXIT MODIFY (0, 1?29)
SET END OF MODIFY TO TRUE
SET END OF PROCESS TO TRUE
DISPLAY UPDATE MENU
EXIT MODIFY (0, 1?11)
SET END OF MODIFY TO TRUE
DISPLAY UPDATE MENU
EXIT UPDATE (0, 1?15)
SET END OF MEMBER TO TRUE
BILLING STATEMENT (0, 1?4)
MEMBER LIST (0, 1?5)
SALES REPORT (0, 1?6)
EXIT PROGRAM (0, 1?7)
SET END OF SYSTEM TO TRUE
?1 - END OF SYSTEM
?2 - MAIN MENU CHOICE = 1
?3 - MAIN MENU CHOICE = 2
?4 - MAIN MENU CHOICE = 3
?5 - MAIN MENU CHOICE = 4
?6 - MAIN MENU CHOICE = 5
?7 - MAIN MENU CHOICE = 6
?8 - END OF TRANSACTIONS
?9 - END OF MEMBERS
?10 - VALID ACCOUNT NUMBER
?11 - INVALID ACCOUNT NUMBER
?12 - UPDATE MENU CHOICE = 1
?13 - UPDATE MENU CHOICE = 2
?14 - UPDATE MENU CHOICE = 3
?15 - UPDATE MENU CHOICE = 4
?16 - END OF MODIFY
?17 - VALID NAME
?18 - INVALID NAME
?19 - PROMPT RESPONSE = YES
?20 - PROMPT RESPONSE = NO
?21 - END OF PROCESS
?22 - MODIFY MENU CHOICE = 0
?23 - MODIFY MENU CHOICE = 1
?24 - MODIFY MENU CHOICE = 2
?25 - MODIFY MENU CHOICE = 3
?26 - MODIFY MENU CHOICE = 4
?27 - MODIFY MENU CHOICE = 5
?28 - MODIFY MENU CHOICE = 6
?29 - MODIFY MENU CHOICE = 7

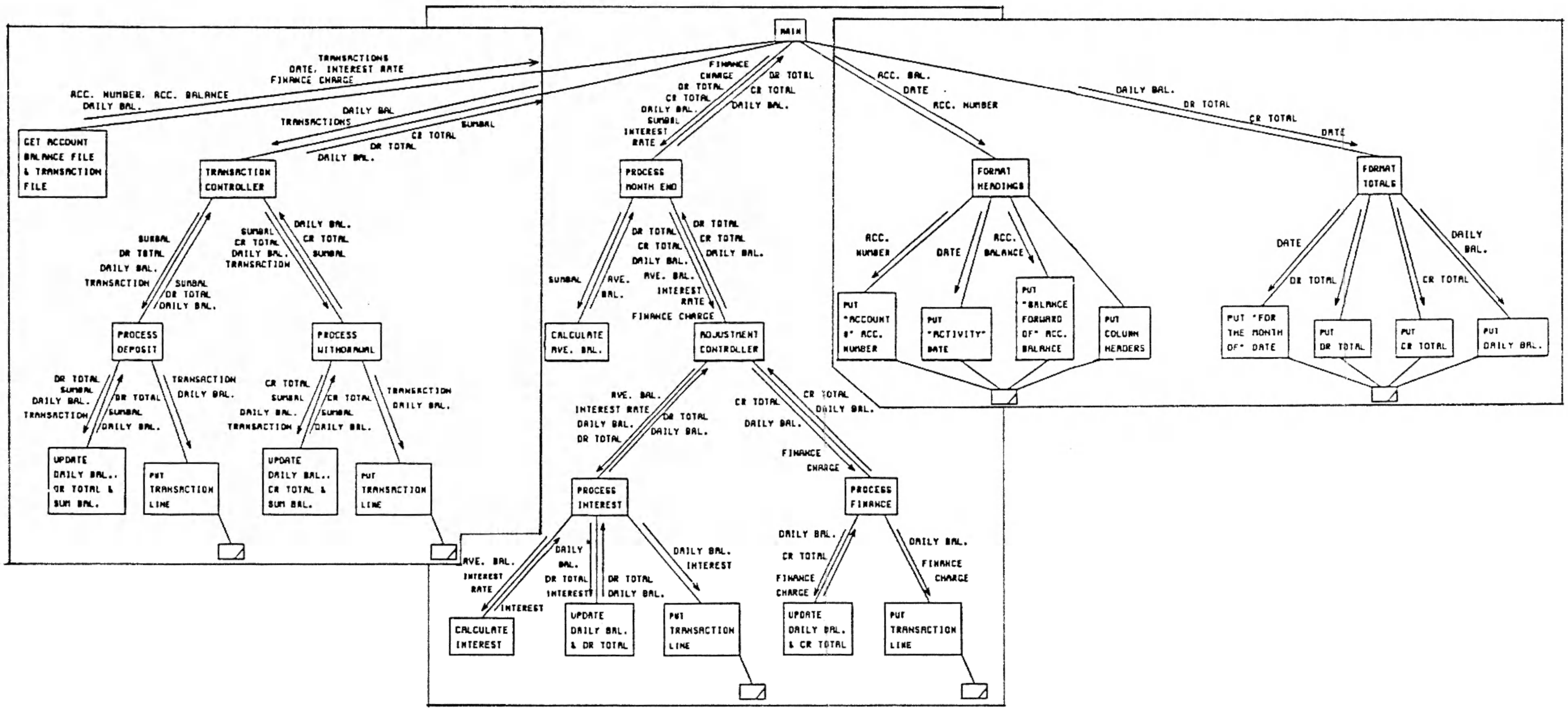
?1 - END OF SYSTEM
?2 - MAIN MENU CHOICE = 1
?3 - MAIN MENU CHOICE = 2
?4 - MAIN MENU CHOICE = 3
?5 - MAIN MENU CHOICE = 4
?6 - MAIN MENU CHOICE = 5
?7 - MAIN MENU CHOICE = 6
?8 - END OF TRANSACTIONS
?9 - END OF MEMBERS
?10 - VALID ACCOUNT NUMBER
?11 - INVALID ACCOUNT NUMBER
?12 - UPDATE MENU CHOICE = 1
?13 - UPDATE MENU CHOICE = 2
?14 - UPDATE MENU CHOICE = 3
?15 - UPDATE MENU CHOICE = 4
?16 - END OF MODIFY
?17 - VALID NAME
?18 - INVALID NAME
?19 - PROMPT RESPONSE = YES
?20 - PROMPT RESPONSE = NO
?21 - END OF PROCESS
?22 - MODIFY MENU CHOICE = 0
?23 - MODIFY MENU CHOICE = 1
?24 - MODIFY MENU CHOICE = 2
?25 - MODIFY MENU CHOICE = 3
?26 - MODIFY MENU CHOICE = 4
?27 - MODIFY MENU CHOICE = 5
?28 - MODIFY MENU CHOICE = 6
?29 - MODIFY MENU CHOICE = 7

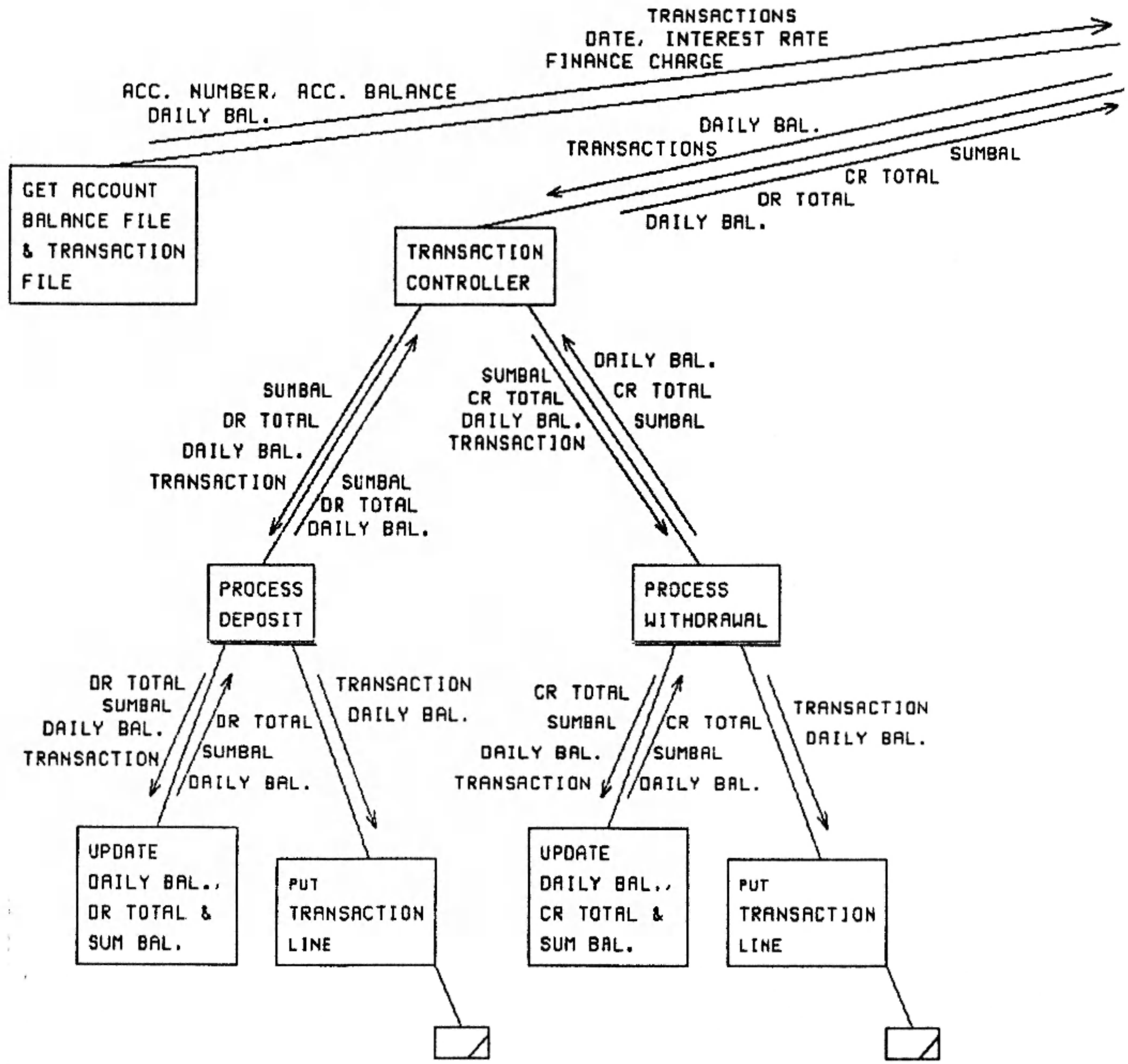
- JECT ACER TEM
  - SET END OF MANAGER TO FALSE
  - PROJECT MANAGER (1,N)?1
    - DISPLAY MAIN MENU
    - SET END OF EDITOR TO FALSE
    - SET END OF OUTPUTS TO FALSE
    - COMPONENT EDITOR (0,1)?2
      - EDITOR (0,N)?5
        - READ COMP FILE NAME
        - EDIT COMP FILE
          - EDIT VALID COMP FILE (0,1)?6
            - COPY COMP FILE INTO TEMP FILE
            - SET END OF EDIT TEMP TO FALSE
            - EDIT TEMP FILE (1,T)?8
              - DISPLAY EDITOR MENU
              - PROCESS EDITOR MENU CHOICE
                - EDIT NEW COMP FILE (0,1)?12
                  - SET END OF EDIT TEMP TO TRUE
                - ⊕
                - ADD COMPONENT (0,1)?13
                  - READ AND ENTER KEYWORD
                  - READ AND ENTER DATA
                - ⊕
                - DELETE COMPONENT (0,1)?14
                  - READ COMP ID
                  - PROCESS COMP ID
                    - PROCESS VALID ID (0,1)?24
                      - DELETE KEYWORD
                      - DELETE DATA
                    - ⊕
                    - END OF DELETE (0,1)?25
                - ⊕
                - CHANGE COMPONENT (0,1)?15
                  - READ COMP ID
                  - PROCESS COMP ID
                    - PROCESS VALID ID (0,1)?24
                      - CHANGE KEYWORD
                      - CHANGE DATA
                    - ⊕
                    - END OF CHANGE (0,1)?25
                - ⊕
                - LIST COMPONENTS (0,1)?16
                  - DISPLAY COMPONENTS IN TEMP FILE
                - ⊕
                - QUIT (0,1)?17
                  - COPY TEMP FILE INTO COMP FILE
                  - SET END OF EDITOR TO TRUE
                  - SET END OF EDIT TEMP TO TRUE
                - ⊕
                - ABORT (0,1)?18
                  - DELETE TEMP FILE
                  - SET END OF EDITOR TO TRUE
                  - SET END OF EDIT TEMP TO TRUE
          - ⊕
          - SET END OF EDITOR TO TRUE (0,1)?7
    - ⊕
    - PROCESS TRACE (0,1)?3
      - PROCESS COMP FILE NAME
        - READ COMP FILE NAME
        - TRACE VALID COMP FILE (0,1)?6
          - PERFORM TRACE
          - SET END OF OUTPUTS TO FALSE
          - PROCESS TRACE RETURN CODE
            - PROCESS TRACE ERROR (0,1)?9
              - DISPLAY RETURN CODE WITH ERROR MESSAGE
            - ⊕
            - PROCESS TRACE REPORTS (0,1)?10
              - PRODUCE OUTPUTS (0,O)?11
                - DISPLAY OUTPUT MENU
                - PROCESS OUTPUT MENU CHOICE
                  - PRINT ACTIVITY REPORT (0,1)?19
                  - ⊕
                  - PRINT SYSTEM REPORT (0,1)?20
                  - ⊕
                  - PRINT ACTIVITY TO REPORT (0,1)?21
                  - ⊕
                  - PRINT GANTT CHART (0,1)?22
                  - ⊕
                  - SET END OF OUTPUTS TO TRUE (0,1)?23
        - ⊕
        - END TRACE PROCESSING (0,1)?7
    - ⊕
    - SET END OF MANAGER TO TRUE (0,1)?4

?1 END OF MANAGER
?2 MAIN MENU CHOICE : 1
?3 - MAIN MENU CHOICE : 2
?4 - MAIN MENU CHOICE : 3
?5 END OF EDITOR
?6 - VALID COMP FILE NAME
?7 - INVALID COMP FILE NAME
?8 END OF EDIT TEMP
?9 - TRACE NOT OK
?10 TRACE OK
?11 - END OF OUTPUTS
?12 - EDITOR MENU CHOICE : 0
?13 - EDITOR MENU CHOICE : 1
?14 - EDITOR MENU CHOICE : 2
?15 - EDITOR MENU CHOICE : 3
?16 - EDITOR MENU CHOICE : 4
?17 - EDITOR MENU CHOICE : 5
?18 - EDITOR MENU CHOICE : 6
?19 - OUTPUT MENU CHOICE : 1
?20 - OUTPUT MENU CHOICE : 2
?21 - OUTPUT MENU CHOICE : 3
?22 - OUTPUT MENU CHOICE : 4
?23 - OUTPUT MENU CHOICE : 5
?24 - VALID ID
?25 - INVALID ID

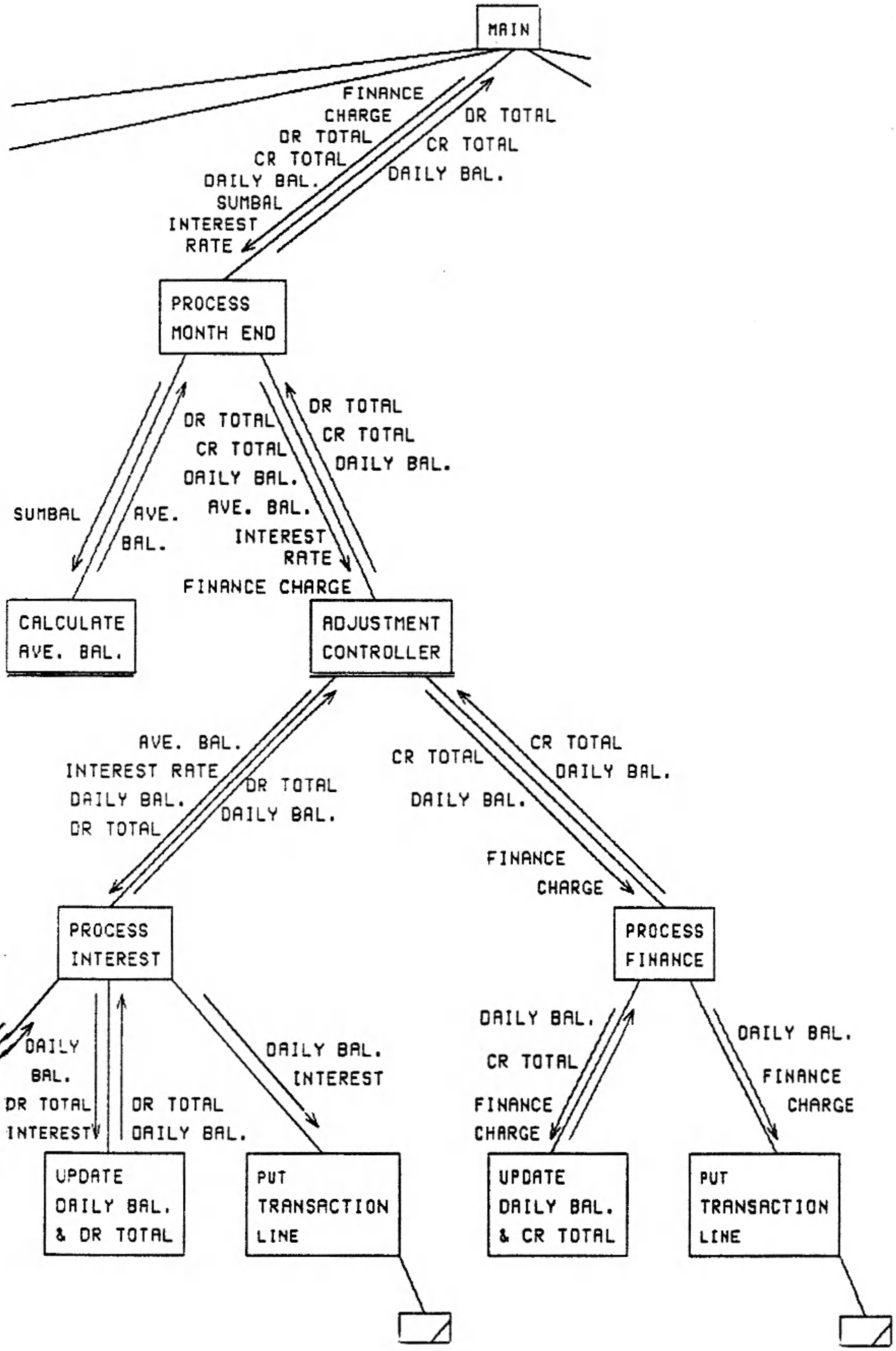
?1 - END OF MANAGER
?2 - MAIN MENU CHOICE = 1
?3 - MAIN MENU CHOICE = 2
?4 - MAIN MENU CHOICE = 3
?5 - END OF EDITOR
?6 - VALID COMP FILE NAME
?7 - INVALID COMP FILE NAME
?8 - END OF EDIT TEMP
?9 - TRACE NOT OK
?10 - TRACE OK
?11 - END OF OUTPUTS
?12 - EDITOR MENU CHOICE = 0
?13 - EDITOR MENU CHOICE = 1
?14 - EDITOR MENU CHOICE = 2
?15 - EDITOR MENU CHOICE = 3
?16 - EDITOR MENU CHOICE = 4
?17 - EDITOR MENU CHOICE = 5
?18 - EDITOR MENU CHOICE = 6
?19 - OUTPUT MENU CHOICE = 1
?20 - OUTPUT MENU CHOICE = 2
?21 - OUTPUT MENU CHOICE = 3
?22 - OUTPUT MENU CHOICE = 4
?23 - OUTPUT MENU CHOICE = 5
?24 - VALID ID
?25 - INVALID ID

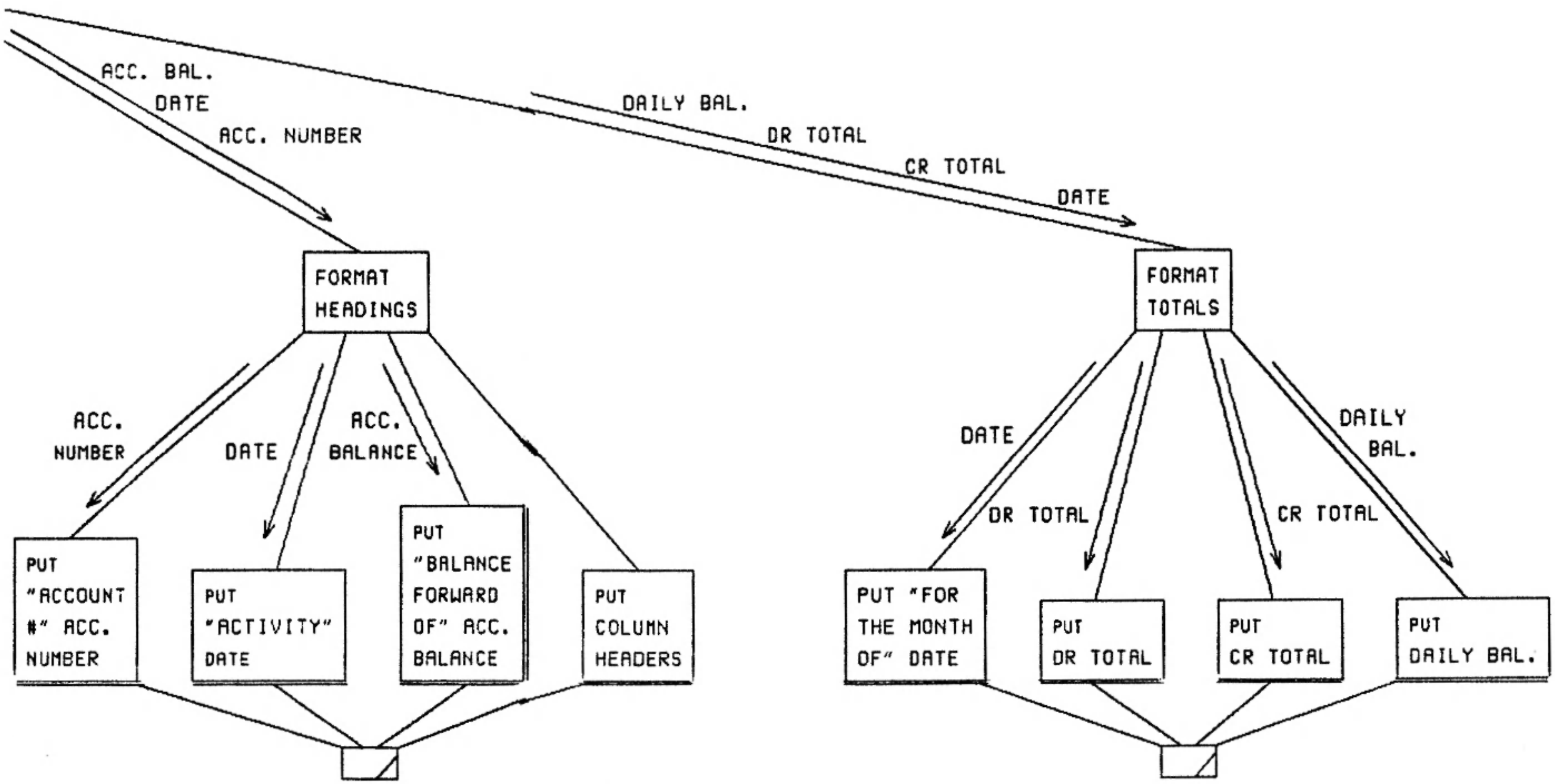
Yourdon-Constantine
Savings Account



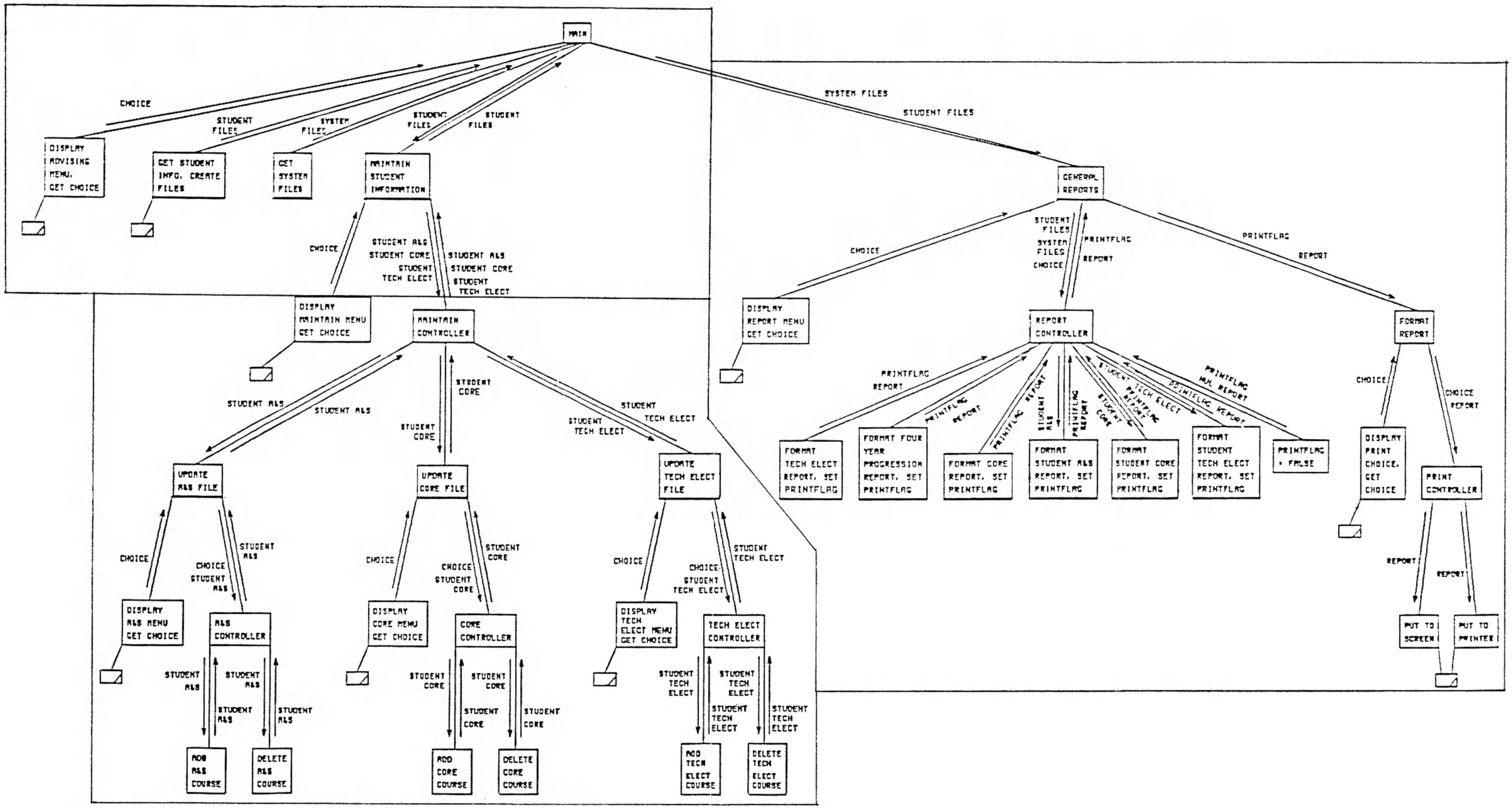


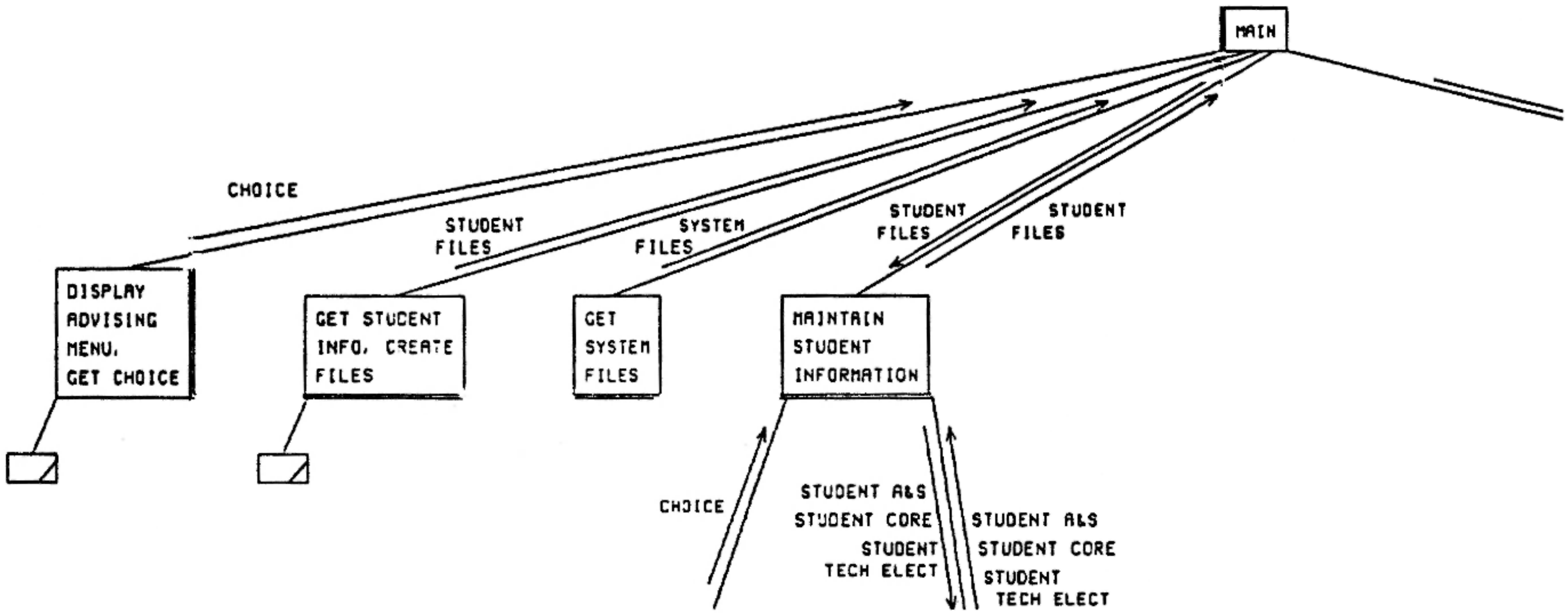
TRANSACTIONS
DATE, INTEREST RATE
FINANCE CHARGE
ACC. NUMBER, ACC. BALANCE
DAILY BAL.
DAILY BAL.
TRANSACTIONS
SUMBAL
CR TOTAL
DR TOTAL
DAILY BAL.
GET ACCOUNT BALANCE FILE & TRANSACTION FILE
TRANSACTION CONTROLLER
SUMBAL
DR TOTAL
DAILY BAL.
TRANSACTION
SUMBAL
DR TOTAL
DAILY BAL.
SUMBAL
CR TOTAL
DAILY BAL.
TRANSACTION
DAILY BAL.
CR TOTAL
SUMBAL
PROCESS DEPOSIT
PROCESS WITHDRAWAL
DR TOTAL
SUMBAL
DAILY BAL.
TRANSACTION
DR TOTAL
SUMBAL
DAILY BAL.
TRANSACTION
DAILY BAL.
CR TOTAL
SUMBAL
DAILY BAL.
TRANSACTION
CR TOTAL
SUMBAL
DAILY BAL.
TRANSACTION
DAILY BAL.
UPDATE DAILY BAL., DR TOTAL & SUM BAL.
PUT TRANSACTION LINE
UPDATE DAILY BAL., CR TOTAL & SUM BAL.
PUT TRANSACTION LINE

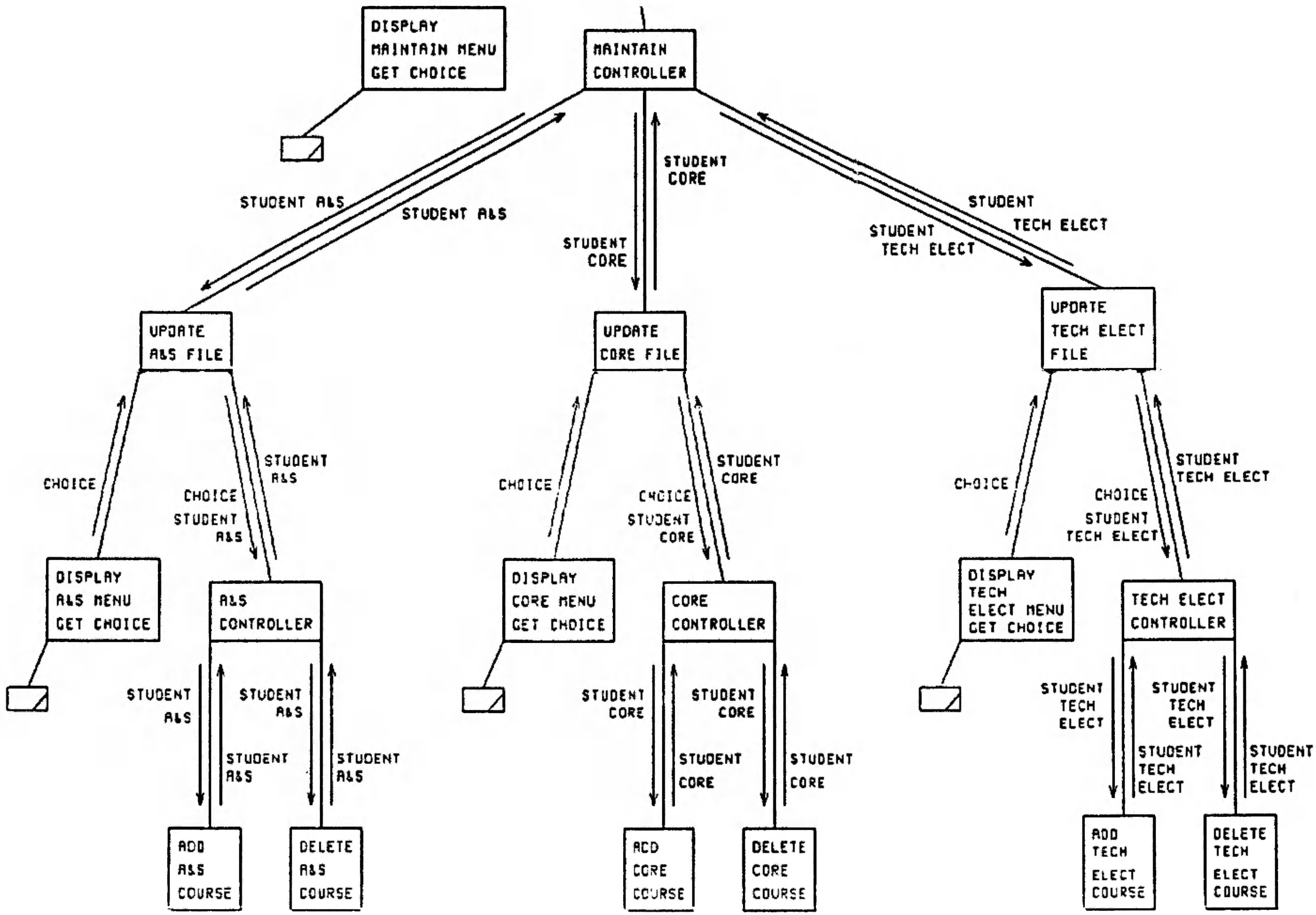

MAIN
FINANCE CHARGE
DR TOTAL
CR TOTAL
DAILY BAL.
SUMBAL
INTEREST RATE
DR TOTAL
CR TOTAL
DAILY BAL.
PROCESS MONTH END
SUMBAL
AVE. BAL.
DR TOTAL
CR TOTAL
DAILY BAL.
AVE. BAL.
INTEREST RATE
FINANCE CHARGE
DR TOTAL
CR TOTAL
DAILY BAL.
CALCULATE AVE. BAL.
ADJUSTMENT CONTROLLER
AVE. BAL.
INTEREST RATE
DAILY BAL.
DR TOTAL
DR TOTAL
DAILY BAL.
CR TOTAL
DAILY BAL.
FINANCE CHARGE
CR TOTAL
DAILY BAL.
PROCESS INTEREST
PROCESS FINANCE
AVE. BAL.
INTEREST RATE
INTEREST
DAILY BAL.
DR TOTAL
INTEREST
DR TOTAL
DAILY BAL.
DAILY BAL.
INTEREST
DAILY BAL.
CR TOTAL
FINANCE CHARGE
DAILY BAL.
FINANCE CHARGE
CALCULATE INTEREST
UPDATE DAILY BAL. & DR TOTAL
PUT TRANSACTION LINE
UPDATE DAILY BAL. & CR TOTAL
PUT TRANSACTION LINE

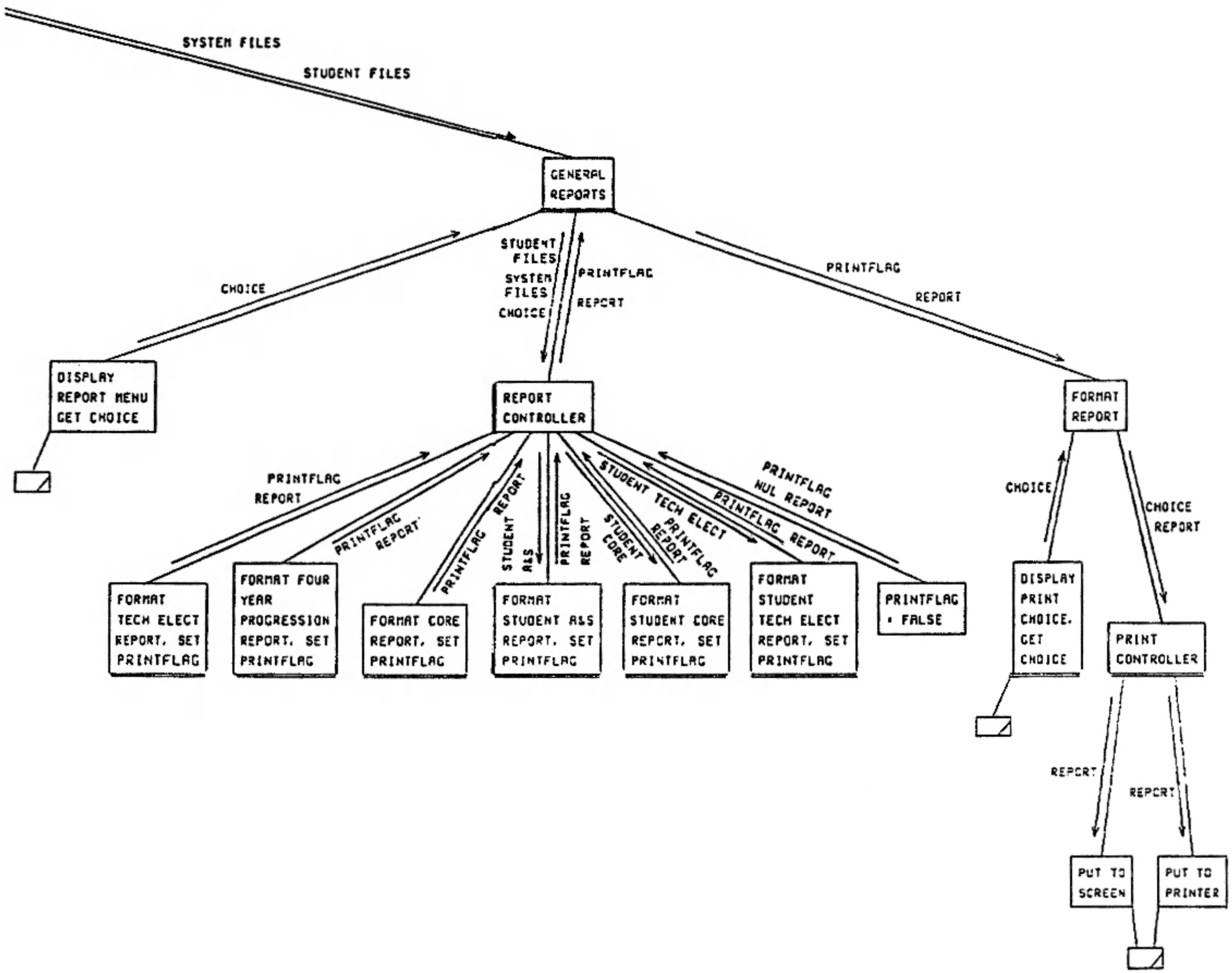

ACC. BAL.
DATE
ACC. NUMBER
DAILY BAL.
DR TOTAL
CR TOTAL
DATE
FORMAT HEADINGS
FORMAT TOTALS
ACC. NUMBER
DATE
ACC. BALANCE
DATE
DR TOTAL
CR TOTAL
DAILY BAL.
PUT "ACCOUNT #" ACC. NUMBER
PUT "ACTIVITY" DATE
PUT "BALANCE FORWARD OF" ACC. BALANCE
PUT COLUMN HEADERS
PUT "FOR THE MONTH OF" DATE
PUT DR TOTAL
PUT CR TOTAL
PUT DAILY BAL.

Yourdon-Constantine
Advising



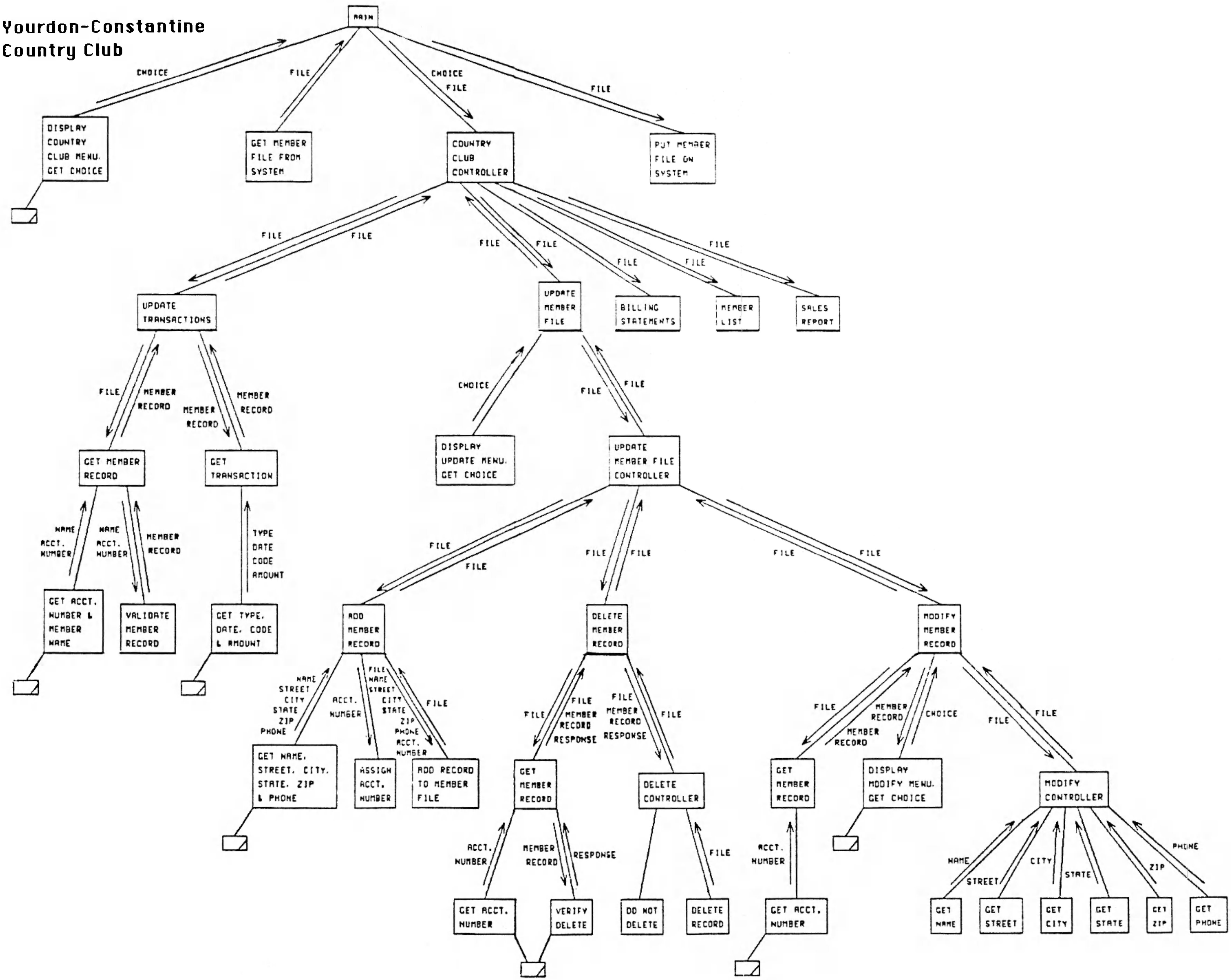

MAIN
CHOICE
STUDENT FILES
SYSTEM FILES
STUDENT FILES
STUDENT FILES
DISPLAY ADVISING MENU, GET CHOICE
GET STUDENT INFO, CREATE FILES
GET SYSTEM FILES
MAINTAIN STUDENT INFORMATION
CHOICE
STUDENT A&S
STUDENT CORE
STUDENT TECH ELECT
STUDENT A&S
STUDENT CORE
STUDENT TECH ELECT


DISPLAY MAINTAIN MENU GET CHOICE
MAINTAIN CONTROLLER
STUDENT A&S
STUDENT A&S
STUDENT CORE
STUDENT CORE
STUDENT TECH ELECT
STUDENT TECH ELECT
UPDATE A&S FILE
UPDATE CORE FILE
UPDATE TECH ELECT FILE
CHOICE
CHOICE STUDENT A&S
STUDENT A&S
CHOICE
CHOICE STUDENT CORE
STUDENT CORE
CHOICE
CHOICE STUDENT TECH ELECT
STUDENT TECH ELECT
DISPLAY A&S MENU GET CHOICE
A&S CONTROLLER
DISPLAY CORE MENU GET CHOICE
CORE CONTROLLER
DISPLAY TECH ELECT MENU GET CHOICE
TECH ELECT CONTROLLER
STUDENT A&S
STUDENT A&S
STUDENT A&S
STUDENT A&S
STUDENT CORE
STUDENT CORE
STUDENT CORE
STUDENT CORE
STUDENT TECH ELECT
STUDENT TECH ELECT
STUDENT TECH ELECT
STUDENT TECH ELECT
ADD A&S COURSE
DELETE A&S COURSE
ADD CORE COURSE
DELETE CORE COURSE
ADD TECH ELECT COURSE
DELETE TECH ELECT COURSE

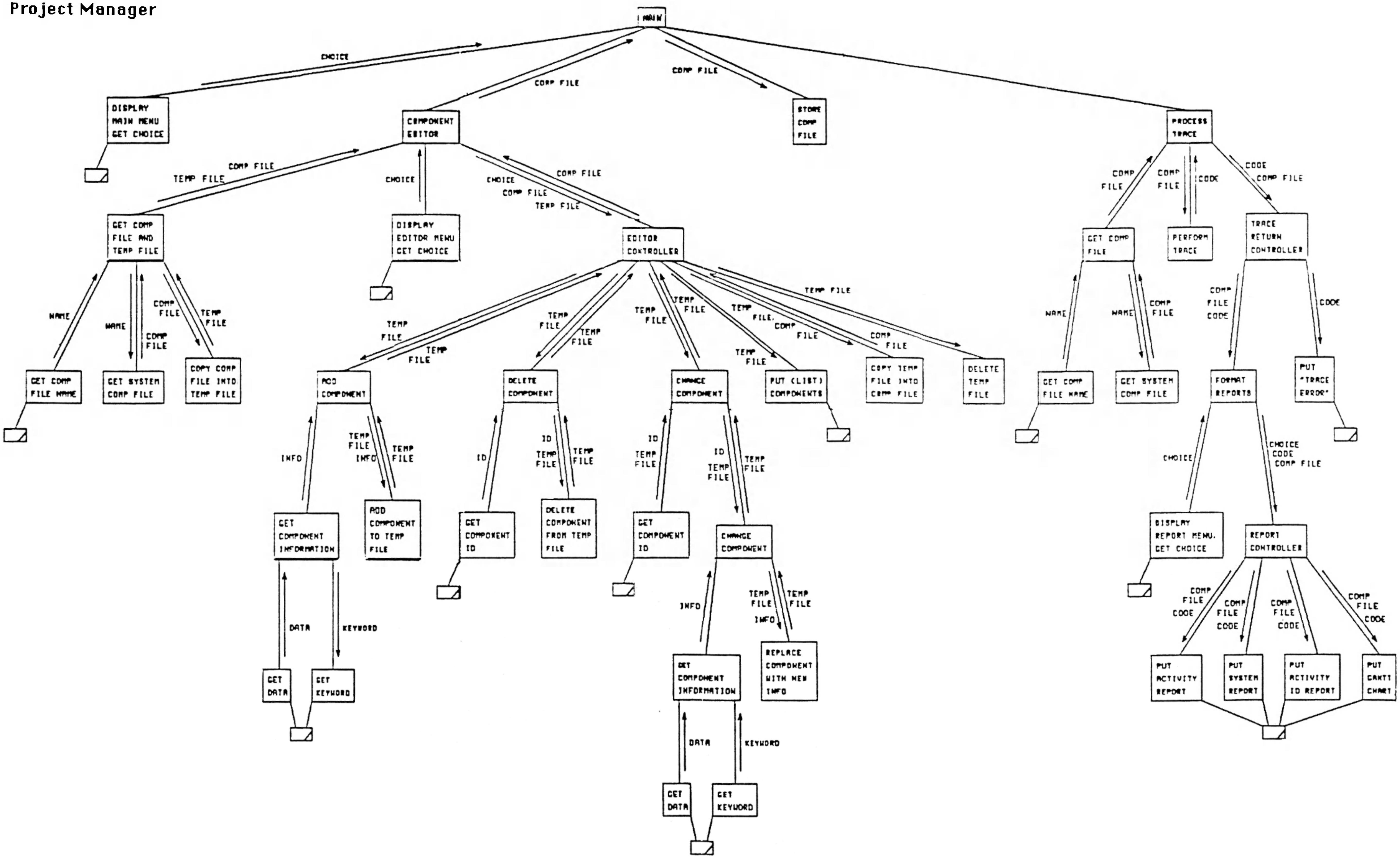


SYSTEM FILES
STUDENT FILES
GENERAL REPORTS
CHOICE
STUDENT FILES
SYSTEM FILES
CHOICE
PRINTFLAG
REPORT
PRINTFLAG
REPORT
DISPLAY REPORT MENU GET CHOICE
REPORT CONTROLLER
FORMAT REPORT
PRINTFLAG
REPORT
PRINTFLAG
REPORT
PRINTFLAG
REPORT
STUDENT A&S
PRINTFLAG
REPORT
STUDENT CORE
REPORT
PRINTFLAG
STUDENT TECH ELECT
PRINTFLAG
REPORT
PRINTFLAG
NUL REPORT
CHOICE
CHOICE
REPORT
FORMAT TECH ELECT REPORT, SET PRINTFLAG
FORMAT FOUR YEAR PROGRESSION REPORT, SET PRINTFLAG
FORMAT CORE REPORT, SET PRINTFLAG
FORMAT STUDENT A&S REPORT, SET PRINTFLAG
FORMAT STUDENT CORE REPORT, SET PRINTFLAG
FORMAT STUDENT TECH ELECT REPORT, SET PRINTFLAG
PRINTFLAG = FALSE
DISPLAY PRINT CHOICE, GET CHOICE
PRINT CONTROLLER
REPORT
REPORT
PUT TO SCREEN
PUT TO PRINTER

Yourdon-Constantine
Country Club



Yourdon-Constantine
Project Manager



Appendix E

Spreadsheet Data

Combined Results

Mean Time - Training	SA	AD	CC	PM	ALL SYSTEMS
HCS	0:09:27	0:07:30	0:07:04	0:07:29	0:07:52
JACKSON	0:06:45	0:06:00	0:05:19	0:05:03	0:05:47
W-O	0:08:40	0:07:12	0:06:51	0:06:05	0:07:12
Y-C	0:06:56	0:07:50	0:06:19	0:06:11	0:06:49
ALL METHODS	0:07:57	0:07:08	0:06:23	0:06:12	0:06:55

Spreadsheet Data for Diagram 1

Mean Time - Questions	SA	AD	CC	PM	ALL SYSTEMS
HCS	0:11:30	0:09:15	0:07:58	0:08:33	0:09:19
JACKSON	0:08:54	0:07:51	0:08:32	0:07:45	0:08:15
W-O	0:11:11	0:08:47	0:09:28	0:08:06	0:09:23
Y-C	0:08:14	0:10:43	0:09:26	0:08:17	0:09:10
ALL METHODS	0:09:57	0:09:09	0:08:51	0:08:10	0:09:02

Spreadsheet Data for Diagram 2

Mean Number Wrong	SA	AD	CC	PM	ALL SYSTEMS
HCS	2.83333333	2.91666667	2	0.91666667	2.16666667
JACKSON	3.41666667	2.58333333	1.33333333	1.83333333	2.29166667
W-O	3.33333333	2.91666667	2	1	2.3125
Y-C	3.25	3.33333333	3	2.75	3.08333333
ALL METHODS	3.20833333	2.9375	2.08333333	1.625	2.46354167

Spreadsheet Data for Diagram 7

Mean Rate	SA	AD	CC	PM	ALL SYSTEMS
HCS	2.41666667	2.58333333	2.16666667	2.5	2.41666667
JACKSON	2.66666667	2.08333333	2	2.25	2.25
W-O	3.25	3.16666667	3	3.16666667	3.14583333
Y-C	2.83333333	3.41666667	2.75	3.66666667	3.16666667
ALL METHODS	2.79166667	2.8125	2.47916667	2.89583333	2.74479167

Spreadsheet Data for Diagram 19

Combined Results

External Behavior					-
	HOS	JACKSON	W-0	Y-C	ALL METHODS
Savings Account	54.1666667	58.3333333	62.5	75	62.5
Advising	27.7777778	44.4444444	41.6666667	50	40.97222222
Country Club	22.2222222	25	30.5555556	47.2222222	31.25
Project Manager	18.75	22.9166667	10.4166667	36.1111111	21.11111111
All Systems	27.7777778	34.7222222	31.9444444	50	35.81560284
Location of Action/Decision					
	HOS	JACKSON	W-0	Y-C	ALL METHODS
Savings Account	5.55555556	13.8888889	2.77777778	11.1111111	8.333333333
Advising	22.9166667	10.4166667	16.6666667	5.55555556	18.33333333
Country Club	8.33333333	0	0	0	2.083333333
Project Manager	0	33.3333333	12.5	41.6666667	21.875
All Systems	11.6666667	15	10	21.2962963	14.31623932
Contents of Files/Output					
	HOS	JACKSON	W-0	Y-C	ALL METHODS
Savings Account	38.8888889	30.5555556	27.7777778	41.6666667	34.72222222
Advising	37.5	25	29.1666667	13.8888889	25
Country Club	12.5	4.16666667	18.75	27.0833333	15.625
Project Manager	8.33333333	4.16666667	8.33333333	16.6666667	10.18518519
All Systems	23.4848485	15.1515152	21.2121212	25	21.37681159
Modification					
	HOS	JACKSON	W-0	Y-C	ALL METHODS
Savings Account	20.8333333	45.8333333	58.3333333	8.33333333	33.33333333
Advising	41.6666667	33.3333333	41.6666667	66.6666667	45.83333333
Country Club	37.5	20.8333333	16.6666667	25	25
Project Manager	0	8.33333333	8.33333333	16.6666667	8.333333333
All Systems	22.6190476	26.1904762	29.7619048	23.8095238	25.5952381

Spreadsheet Data for Diagrams 10, 11 & 12

Professional Results

Mean Time - Training	SA	AD	CC	PM	ALL SYSTEMS
HCS	0:09:25	0:06:50	0:07:03	0:06:45	0:07:31
JACKSON	0:06:20	0:06:22	0:05:02	0:05:02	0:05:41
W-O	0:07:07	0:06:54	0:07:25	0:05:31	0:06:44
Y-C	0:07:08	0:06:25	0:06:14	0:06:08	0:06:29
ALL METHODS	0:07:30	0:06:38	0:06:26	0:05:52	0:06:36

Spreadsheet Data for Diagram 3

Mean Time - Questions	SA	AD	CC	PM	ALL SYSTEMS
HCS	0:11:20	0:08:18	0:07:54	0:07:38	0:08:47
JACKSON	0:07:57	0:08:31	0:08:00	0:07:04	0:07:53
W-O	0:10:15	0:08:00	0:09:38	0:07:05	0:08:45
Y-C	0:09:06	0:10:47	0:07:11	0:07:40	0:08:41
ALL METHODS	0:09:39	0:08:54	0:08:11	0:07:22	0:08:31

Spreadsheet Data for Diagram 4

Mean Number Wrong	SA	AD	CC	PM	ALL SYSTEMS
HCS	2.16666667	3.5	1.5	1	2.04166667
JACKSON	3.16666667	1.83333333	1.83333333	1.66666667	2.125
W-O	4	2.83333333	2.33333333	0.66666667	2.45833333
Y-C	4	3	2.83333333	2.83333333	3.16666667
ALL METHODS	3.33333333	2.79166667	2.125	1.54166667	2.44791667

Spreadsheet Data for Diagram 8

Mean Rate	SA	AD	CC	PM	ALL SYSTEMS
HCS	2.33333333	3.16666667	2.16666667	2.83333333	2.625
JACKSON	2.83333333	2.16666667	2.16666667	2.66666667	2.45833333
W-O	3.83333333	3.16666667	3.5	3.33333333	3.45833333
Y-C	3.33333333	3.5	2.66666667	3.66666667	3.29166667
ALL METHODS	3.08333333	3	2.625	3.125	2.95833333

Spreadsheet Data for Diagram 20

Professional Results

External Behavior -					
	HOS	JACKSON	W-O	Y-C	ALL METHODS
Savings Account	33.3333333	41.6666667	66.6666667	91.6666667	58.33333333
Advising	27.7777778	44.4444444	38.8888889	44.4444444	38.88888889
Country Club	22.2222222	38.8888889	33.3333333	44.4444444	34.72222222
Project Manager	20.8333333	16.6666667	8.33333333	33.3333333	18.88888889
All Systems	25	33.3333333	31.9444444	50	34.75177305
Location of Action/Decision					
	HOS	JACKSON	W-O	Y-C	ALL METHODS
Savings Account	0	16.6666667	5.55555556	16.6666667	9.722222222
Advising	33.3333333	0	16.6666667	0	17.77777778
Country Club	0	0	0	0	0
Project Manager	0	33.3333333	0	33.3333333	16.66666667
All Systems	13.3333333	11.6666667	8.33333333	20.3703704	13.24786325
Contents of Files/Output					
	HOS	JACKSON	W-O	Y-C	ALL METHODS
Savings Account	38.8888889	27.7777778	38.8888889	55.5555556	40.27777778
Advising	41.6666667	16.6666667	25	5.55555556	20.37037037
Country Club	8.33333333	8.33333333	25	20.8333333	15.625
Project Manager	8.33333333	0	16.6666667	16.6666667	11.11111111
All Systems	22.7272727	13.6363636	27.2727273	24.3589744	22.10144928
Modification					
	HOS	JACKSON	W-O	Y-C	ALL METHODS
Savings Account	16.6666667	50	66.6666667	0	33.33333333
Advising	50	16.6666667	50	83.3333333	50
Country Club	25	16.6666667	16.6666667	33.3333333	22.91666667
Project Manager	0	16.6666667	0	33.3333333	12.5
All Systems	19.047619	26.1904762	30.952381	30.952381	26.78571429

Spreadsheet Data for Diagrams 13, 14 & 15

Student Results

Mean Time - Training	SA	AD	CC	PM	ALL SYSTEMS
HOS	0:09:28	0:08:10	0:07:04	0:08:14	0:08:14
JACKSON	0:07:11	0:05:38	0:05:37	0:05:03	0:05:52
W-O	0:10:13	0:07:29	0:06:17	0:06:38	0:07:40
Y-C	0:06:45	0:09:15	0:06:25	0:06:14	0:07:10
ALL METHODS	0:08:24	0:07:38	0:06:21	0:06:32	0:07:14

Spreadsheet Data for Diagram 5

Mean Time - Questions	SA	AD	CC	PM	ALL SYSTEMS
HOS	0:11:39	0:10:13	0:08:02	0:09:28	0:09:51
JACKSON	0:09:52	0:07:10	0:09:04	0:08:26	0:08:38
W-O	0:12:07	0:09:33	0:09:17	0:09:07	0:10:01
Y-C	0:07:23	0:10:39	0:11:41	0:08:54	0:09:39
ALL METHODS	0:10:15	0:09:24	0:09:31	0:08:59	0:09:32

Spreadsheet Data for Diagram 6

Mean Number Wrong	SA	AD	CC	PM	ALL SYSTEMS
HOS	3.5	2.33333333	2.5	0.83333333	2.29166667
JACKSON	3.66666667	3.33333333	0.83333333	2	2.45833333
W-O	2.66666667	3	1.66666667	1.33333333	2.16666667
Y-C	2.5	3.66666667	3.16666667	2.66666667	3
ALL METHODS	3.08333333	3.08333333	2.04166667	1.70833333	2.47916667

Spreadsheet Data for Diagram 9

Mean Rate	SA	AD	CC	PM	ALL SYSTEMS
HOS	2.5	2	2.16666667	2.16666667	2.20833333
JACKSON	2.5	2	1.83333333	1.83333333	2.04166667
W-O	2.66666667	3.16666667	2.5	3	2.83333333
Y-C	2.33333333	3.33333333	2.83333333	3.66666667	3.04166667
ALL METHODS	2.5	2.625	2.33333333	2.66666667	2.53125

Spreadsheet Data for Diagram 21

Student Results

External Behavior					
	HOS	JACKSON	W-O	Y-C	ALL METHODS
Savings Account	75	75	58.3333333	58.3333333	66.66666667
Advising	27.7777778	44.4444444	44.4444444	55.5555556	43.05555556
Country Club	22.2222222	11.1111111	27.7777778	50	27.77777778
Project Manager	16.6666667	29.1666667	12.5	38.8888889	23.33333333
All Systems	30.5555556	36.1111111	31.9444444	50	36.87943262
Location of Action/Decision					
	HOS	JACKSON	W-O	Y-C	ALL METHODS
Savings Account	11.1111111	11.1111111	0	5.55555556	6.944444444
Advising	12.5	20.8333333	16.6666667	11.1111111	18.88888889
Country Club	16.6666667	0	0	0	4.166666667
Project Manager	0	33.3333333	25	50	27.08333333
All Systems	10	18.3333333	11.6666667	22.2222222	15.38461538
Contents of Files/Output					
	HOS	JACKSON	W-O	Y-C	ALL METHODS
Savings Account	38.8888889	33.3333333	16.6666667	27.7777778	29.16666667
Advising	33.3333333	33.3333333	33.3333333	22.2222222	29.62962963
Country Club	16.6666667	0	12.5	33.3333333	15.625
Project Manager	8.33333333	8.33333333	0	16.6666667	9.259259259
All Systems	24.2424242	16.6666667	15.1515152	25.6410256	20.65217391
Modification					
	HOS	JACKSON	W-O	Y-C	ALL METHODS
Savings Account	25	41.6666667	50	16.6666667	33.33333333
Advising	33.3333333	50	33.3333333	50	41.66666667
Country Club	50	25	16.6666667	16.6666667	27.08333333
Project Manager	0	0	16.6666667	0	4.166666667
All Systems	26.1904762	26.1904762	28.5714286	16.6666667	24.4047619

Spreadsheet Data for Diagrams 16, 17 & 18

Student Spreadsheet Data

	NUMBER 1	NUMBER 2	NUMBER 3	NUMBER 4	NUMBER 5	NUMBER 6
HOS						
Othello Des.	0:00:58	0:01:13	0:02:03	0:00:33	0:00:51	0:01:32
HOS training	0:06:31	0:10:54	0:09:45	0:04:13	0:06:21	0:06:31
System Des.	0:00:36	0:01:37	0:01:03	0:00:24	0:00:35	0:01:09
Total Training	0:08:05	0:13:44	0:12:51	0:05:10	0:07:47	0:09:12
System	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT
Seen HOS	no	no	no	yes	no	no
#1 Time	0:02:19	0:01:57	0:02:51	0:02:25	0:02:17	0:01:08
Answer	B b	B C	B B	B B	B b	B b
#2 Time	0:00:22	0:00:58	0:01:15	0:00:36	0:00:34	0:01:37
Answer	A c	A A	A C	A C	A a	A c
#3 Time	0:01:03	0:00:39	0:02:01	0:00:56	0:01:36	0:02:21
Answer	B b	B A	B C	B B	B b	B b
#4 Time	0:00:57	0:00:55	0:01:46	0:01:58	0:02:02	0:00:37
Answer	D b	D B	D A	D D	D b	D d
#5 Time	0:00:21	0:01:41	0:01:39	0:00:29	0:00:29	0:00:52
Answer	B b	B C	B B	B B	B b	B b
#6 Time	0:00:38	0:02:05	0:01:08	0:01:39	0:00:39	0:01:47
Answer	B b	B B	B C	B C	B b	B b
#7 Time	0:00:20	0:00:27	0:01:30	0:01:20	0:00:14	0:01:43
Answer	C c	C C	C B	C C	C c	C c
#8 Time	0:00:37	0:00:52	0:01:54	0:00:34	0:01:41	0:00:43
Answer	B a	B A	B A	B C	B b	B a
#9 Time	0:00:16	0:01:04	0:01:32	0:02:30	0:00:16	0:01:14
Answer	B b	B B	B C	B B	B b	B b
#10 Time	0:00:16	0:00:16	0:00:58	0:00:15	0:00:21	0:00:27
Answer	C c	C C	C C	C C	C c	C c
TOTAL Time	0:07:09	0:10:52	0:16:34	0:12:42	0:10:09	0:12:29
TOTAL Wrong	3	5	7	3	1	2
HOS Rate	3	2	3	2	2	3
	NUMBER 1	NUMBER 2	NUMBER 3	NUMBER 4	NUMBER 5	NUMBER 6
JACKSON						
Othello Des.	0:00:41	0:01:07	0:01:05	0:00:22	0:00:25	0:00:26
JACK training	0:02:57	0:05:48	0:06:51	0:02:15	0:02:56	0:05:01
System Des.	0:00:38	0:01:03	0:01:01	0:00:24	0:00:37	0:00:45
Total Training	0:04:16	0:07:58	0:08:57	0:03:01	0:03:58	0:06:12
System	ADVISING	ADVISING	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER
Seen JACK	no	no	no	yes	no	no
#1 Time	0:00:43	0:00:39	0:02:42	0:00:24	0:01:19	0:00:29
Answer	C c	C B	A A	C C	A a	C c
#2 Time	0:00:35	0:01:43	0:01:23	0:00:44	0:01:11	0:00:27
Answer	B a	B B	B B	A C	B b	A a
#3 Time	0:01:17	0:01:47	0:01:00	0:01:11	0:00:18	0:02:19
Answer	B c	B B	B B	C C	B b	C a
#4 Time	0:00:27	0:00:40	0:01:20	0:00:23	0:00:13	0:00:30
Answer	A a	A B	C C	B B	C c	B b
#5 Time	0:00:16	0:00:15	0:01:13	0:00:17	0:00:21	0:00:52
Answer	B b	B A	C C	A A	C c	A a
#6 Time	0:00:21	0:00:30	0:00:43	0:00:10	0:00:40	0:00:31
Answer	A a	A A	A A	B B	A a	B a
#7 Time	0:00:08	0:00:11	0:00:51	0:00:32	0:01:01	0:00:24
Answer	C c	C C	B B	A A	B b	A a
#8 Time	0:00:31	0:00:50	0:01:19	0:00:37	0:00:51	0:00:54
Answer	C b	C C	A B	A A	A a	A a
#9 Time	0:00:18	0:00:31	0:01:56	0:01:35	0:00:47	0:01:00
Answer	B c	B B	B B	B C	B b	B b
#10 Time	0:01:18	0:00:49	0:01:14	0:01:45	0:00:25	0:00:53
Answer	A a	A A	C C	C C	C c	C c
TOTAL Time	0:05:54	0:07:55	0:13:41	0:07:38	0:07:06	0:08:19
TOTAL Wrong	4	3	1	2	0	2
JACK Rate	3	2	2	1	2	2

	NUMBER 1	NUMBER 2	NUMBER 3	NUMBER 4	NUMBER 5	NUMBER 6
WARNIER-ORR						
Othello Des.	0:00:09	0:00:42	0:01:10	0:00:20	0:00:18	0:00:33
WO training	0:02:23	0:08:23	0:08:33	0:03:36	0:04:25	0:08:36
System Des.	0:00:33	0:02:06	0:01:40	0:00:36	0:00:53	0:00:53
Total Training	0:03:05	0:11:11	0:11:23	0:04:32	0:05:36	0:10:02
System	COUNTRY CLUB	PROJECT MANAGER	ADVISING	ADVISING	PROJECT MANAGER	COUNTRY CLUB
Seen WO	no	no	yes	yes	no	yes
#1 Time	0:00:12	0:00:31	0:03:37	0:02:07	0:00:51	0:01:32
Answer	A b	C C	C C	C C	C c	A a
#2 Time	0:01:34	0:02:17	0:03:57	0:01:07	0:00:40	0:01:42
Answer	B b	A A	B A	B B	A a	B b
#3 Time	0:00:17	0:01:04	0:00:28	0:02:18	0:00:28	0:00:29
Answer	B b	C C	B B	B B	C c	B b
#4 Time	0:00:11	0:00:26	0:01:44	0:00:21	0:00:54	0:02:46
Answer	C a	B B	A A	A A	B b	C c
#5 Time	0:00:19	0:00:25	0:02:33	0:00:18	0:01:40	0:00:21
Answer	C c	A A	B B	B A	A a	C c
#6 Time	0:00:30	0:00:34	0:00:41	0:00:52	0:00:23	0:00:43
Answer	A a	B B	A A	A A	B b	A a
#7 Time	0:00:14	0:01:09	0:00:20	0:00:08	0:00:49	0:00:24
Answer	B a	A A	C C	C C	A a	B b
#8 Time	0:00:22	0:00:41	0:01:33	0:00:43	0:00:32	0:00:50
Answer	A b	A A	C C	C C	A a	A a
#9 Time	0:00:25	0:01:09	0:00:38	0:00:41	0:00:22	0:00:38
Answer	B b	B B	B B	B B	B b	B b
#10 Time	0:00:25	0:00:38	0:02:22	0:00:55	0:01:44	0:00:48
Answer	C c	C C	A A	A A	C c	C c
TOTAL Time	0:04:29	0:08:54	0:17:53	0:09:30	0:08:23	0:10:13
TOTAL Wrong	4	0	1	1	0	0
WO Rate	4	4	3	4	4	2
	NUMBER 1	NUMBER 2	NUMBER 3	NUMBER 4	NUMBER 5	NUMBER 6
YOURDON-CONSTANTINE						
Othello Des.	0:00:25	0:00:34	0:01:33	0:00:19	0:00:41	0:00:57
YC training	0:03:11	0:05:19	0:08:02	0:02:58	0:04:58	0:07:28
System Des.	0:00:42	0:01:51	0:01:12	0:00:30	0:00:49	0:01:39
Total Training	0:04:18	0:07:44	0:10:47	0:03:47	0:06:28	0:10:04
System	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	ADVISING	ADVISING
Seen YC	no	no	no	yes	no	no
#1 Time	0:00:53	0:00:58	0:01:27	0:01:14	0:02:41	0:00:55
Answer	C c	A C	C C	A A	C c	C c
#2 Time	0:00:16	0:01:37	0:01:55	0:01:43	0:00:31	0:00:34
Answer	A a	B A	A A	B B	B a	B a
#3 Time	0:00:54	0:00:39	0:02:11	0:00:36	0:00:33	0:02:39
Answer	C a	B B	C A	B B	B b	B a
#4 Time	0:00:21	0:00:57	0:00:29	0:00:43	0:00:22	0:00:35
Answer	B b	C A	B B	C C	A a	A a
#5 Time	0:00:21	0:00:19	0:01:00	0:00:32	0:00:41	0:01:34
Answer	A a	C C	A A	C C	B b	B a
#6 Time	0:00:08	0:00:40	0:02:23	0:00:22	0:00:56	0:00:36
Answer	B b	A B	B B	A C	A a	A b
#7 Time	0:00:11	0:00:36	0:00:43	0:01:09	0:00:16	0:00:24
Answer	A a	B A	A A	B B	C c	C c
#8 Time	0:00:06	0:01:13	0:01:30	0:01:00	0:01:40	0:00:27
Answer	A a	A A	A A	A A	C a	C a
#9 Time	0:01:20	0:00:42	0:02:48	0:01:04	0:00:38	0:00:50
Answer	B c	B B	B C	B B	B c	B c
#10 Time	0:00:24	0:00:29	0:00:29	0:01:28	0:00:35	0:00:39
Answer	C c	C A	C C	C A	A a	A b
TOTAL Time	0:04:54	0:08:10	0:14:55	0:09:51	0:08:53	0:09:13
TOTAL Wrong	2	6	2	2	3	7
YC Rate	4	4	3	2	3	3
Diagram Choice	jackson	JACKSON	JACKSON	JACKSON	HOS	JACKSON
Courses Taking	CS420	cs420	CS420	STAT703	cs420	CS420
				RESEARCH		

	NUMBER 7	NUMBER 8	NUMBER 9	NUMBER 10	NUMBER 11	NUMBER 12
HOS						
Othello Des.	0:00:39	0:02:35	0:00:36	0:00:55	0:00:23	0:06:24
HOS training	0:04:26	0:07:36	0:06:01	0:05:56	0:07:32	0:02:57
System Des.	0:00:47	0:01:12	0:01:54	0:01:37	0:00:33	0:01:14
Total Training	0:05:52	0:11:23	0:08:31	0:08:28	0:08:28	0:10:35
System	ADVISING	ADVISING	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER
Seen HOS	no	no	no	no	no	no
#1 Time	0:01:35	0:00:46	0:01:34	0:00:36	0:02:44	0:01:59
Answer	C c	C c	A a	C c	A a	C A
#2 Time	0:00:10	0:01:23	0:01:14	0:00:42	0:01:05	0:00:58
Answer	B b	B a	B b	A a	B b	A A
#3 Time	0:00:48	0:02:14	0:00:29	0:01:07	0:00:47	0:00:56
Answer	B b	B b	B b	C c	B b	C C
#4 Time	0:00:45	0:00:31	0:00:59	0:00:06	0:00:47	0:00:50
Answer	A a	A a	C c	B b	C a	B B
#5 Time	0:00:50	0:01:10	0:01:05	0:01:08	0:00:43	0:01:25
Answer	B a	B a	C c	A a	C c	A B
#6 Time	0:00:35	0:01:07	0:00:26	0:01:18	0:00:34	0:00:35
Answer	A a	A a	A a	B b	A a	B B
#7 Time	0:00:14	0:00:14	0:00:25	0:00:54	0:01:31	0:00:41
Answer	C c	C c	B a	A a	B a	A A
#8 Time	0:01:25	0:00:33	0:00:20	0:00:31	0:01:37	0:00:17
Answer	C b	C c	A b	A a	A c	A A
#9 Time	0:00:19	0:00:18	0:00:19	0:00:38	0:01:01	0:00:57
Answer	B b	B b	B b	B b	B a	B B
#10 Time	0:02:21	0:01:31	0:00:36	0:01:14	0:00:57	0:02:23
Answer	A b	A c	C c	C b	C c	C C
TOTAL Time	0:09:02	0:09:47	0:07:27	0:08:14	0:11:46	0:11:01
TOTAL Wrong	3	3	2	1	4	2
HOS Rate	2	3	2	2	3	4
	NUMBER 7	NUMBER 8	NUMBER 9	NUMBER 10	NUMBER 11	NUMBER 12
JACKSON						
Othello Des.	0:00:53	0:04:36	0:00:32	0:02:05	0:00:42	0:01:19
JACK training	0:03:22	0:04:31	0:02:28	0:03:19	0:06:10	0:06:28
System Des.	0:00:55	0:01:06	0:00:36	0:00:38	0:00:56	0:02:28
Total Training	0:05:10	0:10:13	0:03:36	0:06:02	0:07:48	0:10:15
System	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT
Seen JACK	no	no	no	no	yes	no
#1 Time	0:00:26	0:02:44	0:00:51	0:01:15	0:01:14	0:02:13
Answer	B b	B b	B b	B b	B b	B B
#2 Time	0:01:06	0:01:53	0:00:29	0:00:41	0:00:58	0:01:11
Answer	A a	A a	A a	A b	A a	A A
#3 Time	0:00:58	0:01:41	0:00:16	0:00:50	0:00:52	0:01:14
Answer	B d	B a	B b	B a	B a	B A
#4 Time	0:00:57	0:00:34	0:00:11	0:00:07	0:00:57	0:01:10
Answer	D d	D a	D d	D a	D b	D A
#5 Time	0:01:44	0:01:46	0:00:39	0:00:52	0:01:20	0:01:38
Answer	B a	B b	B b	B c	B b	B A
#6 Time	0:01:02	0:01:45	0:00:57	0:01:14	0:00:40	0:02:16
Answer	B c	B b	B b	B c	B b	B B
#7 Time	0:00:32	0:02:11	0:00:13	0:00:04	0:00:37	0:01:40
Answer	C c	C c	C c	C a	C a	C C
#8 Time	0:01:10	0:01:29	0:00:13	0:00:46	0:00:52	0:00:43
Answer	B a	B a	B b	B a	B d	B A
#9 Time	0:01:09	0:01:02	0:00:14	0:00:08	0:01:48	0:00:23
Answer	B b	B b	B b	B b	B b	B B
#10 Time	0:00:16	0:00:36	0:00:07	0:01:06	0:00:39	0:00:31
Answer	C c	C c	C c	C c	C c	C C
TOTAL Time	0:09:20	0:15:41	0:04:10	0:07:03	0:09:57	0:12:59
TOTAL Wrong	4	3	0	7	4	4
JACK Rate	2	4	1	3	3	2

	NUMBER 7	**NUMBER 8**	**NUMBER 9**	**NUMBER 10**	**NUMBER 11**	**NUMBER 12**
WARNIER-ORR						
Othello Des.	0:00:31	0:00:27	0:01:28	0:02:26	0:00:32	0:04:01
WO training	0:05:16	0:03:46	0:04:10	0:03:37	0:06:06	0:03:37
System Des.	0:00:41	0:00:33	0:02:13	0:01:16	0:00:29	0:01:02
Total Training	0:06:28	0:04:46	0:07:51	0:07:19	0:07:07	0:08:40
System	COUNTRY CLUB	PROJECT MANAGER	ADVISING	ADVISING	PROJECT MANAGER	COUNTRY CLUB
Seen WO	no	yes	no	yes	yes	yes
#1 Time	0:00:42	0:01:00	0:01:42	0:00:36	0:02:59	0:01:45
Answer	A a	C c	C b	C c	C c	A A
#2 Time	0:02:37	0:00:41	0:01:18	0:01:44	0:02:30	0:02:55
Answer	B a	A a	B b	B b	A a	B B
#3 Time	0:01:00	0:01:26	0:00:49	0:01:05	0:00:52	0:01:00
Answer	B b	C c	B a	B c	C a	B B
#4 Time	0:00:38	0:00:39	0:00:16	0:00:33	0:00:51	0:01:22
Answer	C c	B b	A b	A b	B b	C C
#5 Time	0:00:29	0:00:32	0:00:46	0:01:06	0:01:31	0:00:29
Answer	C c	A a	B a	B c	A a	C C
#6 Time	0:00:36	0:00:23	0:00:52	0:00:43	0:01:21	0:01:12
Answer	A a	B b	A a	A c	B a	A A
#7 Time	0:02:43	0:00:24	0:00:15	0:00:31	0:00:25	0:01:26
Answer	B a	A a	C c	C c	A a	B B
#8 Time	0:00:54	0:00:13	0:00:36	0:00:04	0:00:24	0:01:55
Answer	A a	A c	C b	C a	A a	A A
#9 Time	0:01:05	0:04:32	0:00:12	0:00:08	0:00:32	0:00:52
Answer	B b	B a	B b	B c	B b	B B
#10 Time	0:01:06	0:01:11	0:01:05	0:00:33	0:01:19	0:00:33
Answer	C a	C b	A a	A a	C c	C A
TOTAL Time	0:11:52	0:11:01	0:07:51	0:07:03	0:12:44	0:13:29
TOTAL Wrong	3	3	5	6	2	1
WO Rate	4	2	3	4	3	2
	NUMBER 7	**NUMBER 8**	**NUMBER 9**	**NUMBER 10**	**NUMBER 11**	**NUMBER 12**
YOURDON-CONSTANTINE						
Othello Des.	0:00:24	0:02:02	0:00:29	0:01:32	0:00:34	0:06:13
YC training	0:05:14	0:04:12	0:04:05	0:04:41	0:09:50	0:02:49
System Des.	0:01:09	0:00:46	0:01:13	0:00:40	0:01:17	0:02:26
Total Training	0:06:47	0:07:00	0:05:47	0:06:53	0:11:41	0:11:28
System	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	ADVISING	ADVISING
Seen YC	no	no	no	yes	yes	no
#1 Time	0:01:05	0:03:29	0:00:42	0:01:58	0:02:22	0:02:17
Answer	C a	A a	C a	A a	C b	C B
#2 Time	0:00:53	0:02:56	0:00:36	0:01:55	0:01:04	0:01:00
Answer	A a	B b	A a	B c	B a	B A
#3 Time	0:00:38	0:01:16	0:00:55	0:00:28	0:01:12	0:00:57
Answer	C c	B b	C c	B b	B b	B C
#4 Time	0:00:59	0:00:45	0:00:36	0:00:54	0:01:28	0:02:07
Answer	B b	C c	B b	C a	A a	A A
#5 Time	0:01:20	0:00:28	0:00:56	0:00:39	0:00:57	0:01:06
Answer	A c	C c	A a	C c	B a	B B
#6 Time	0:00:49	0:00:27	0:00:49	0:01:32	0:00:33	0:02:24
Answer	B a	A c	B a	A b	A a	A A
#7 Time	0:00:24	0:01:55	0:00:20	0:00:49	0:00:28	0:00:40
Answer	A a	B b	A a	B b	C c	C C
#8 Time	0:00:20	0:00:32	0:00:19	0:01:04	0:00:43	0:01:11
Answer	A a	A b	A a	A a	C b	C C
#9 Time	0:02:37	0:01:22	0:03:04	0:03:02	0:00:32	0:02:45
Answer	B b	B b	B a	B c	B b	B C
#10 Time	0:00:18	0:00:42	0:00:24	0:00:49	0:00:51	0:01:24
Answer	C c	C a	C c	C a	A a	A A
TOTAL Time	0:09:23	0:13:52	0:08:41	0:13:10	0:10:10	0:15:51
TOTAL Wrong	3	3	3	5	4	4
YC Rate	4	4	4	2	3	3
Diagram Choice	hos	WARNIER-ORR	Jackson	warnier-orr	warnier-orr	WARNIER-ORR
Courses Taking	CS420	cs420	CS420	cs300	cs420	cs420
	CS561			cs420		

	NUMBER 13	NUMBER 14	NUMBER 15	NUMBER 16	NUMBER 17	NUMBER 18
HOS						
Othello Des.	0:00:58	0:00:41	0:00:29	0:00:24	0:00:28	0:05:36
HOS training	0:05:34	0:09:51	0:05:38	0:07:37	0:05:52	0:04:03
System Des.	0:01:16	0:01:28	0:00:45	0:00:41	0:01:10	0:01:03
Total Training	0:07:48	0:12:00	0:06:52	0:08:42	0:07:30	0:10:42
System	ADVISING	ADVISING	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER
Seen HOS	no	no	yes	no	no	no
#1 Time	0:00:44	0:01:26	0:00:49	0:01:06	0:01:37	0:01:08
Answer	C c	C c	A A	C c	A b	C a
#2 Time	0:00:34	0:00:26	0:00:41	0:00:47	0:01:29	0:00:56
Answer	B b	B b	B B	A a	B b	A a
#3 Time	0:01:27	0:02:57	0:00:44	0:01:33	0:00:28	0:01:19
Answer	B b	B c	B B	C c	B b	C c
#4 Time	0:00:51	0:02:35	0:00:26	0:00:17	0:00:53	0:00:50
Answer	A a	A b	C C	B b	C c	B b
#5 Time	0:01:18	0:01:41	0:00:23	0:02:02	0:00:00	0:00:43
Answer	B a	B b	C C	A a	C	A a
#6 Time	0:00:27	0:00:59	0:00:48	0:00:22	0:01:02	0:00:20
Answer	A a	A a	A A	B b	A a	B b
#7 Time	0:00:09	0:00:14	0:00:59	0:00:19	0:00:31	0:01:45
Answer	C c	C c	B B	A a	B b	A a
#8 Time	0:00:12	0:02:15	0:00:44	0:00:35	0:00:50	0:01:21
Answer	C c	C c	A A	A a	A a	A a
#9 Time	0:00:13	0:01:37	0:00:30	0:00:14	0:00:18	0:02:10
Answer	B b	B b	B B	B b	B a	B b
#10 Time	0:01:21	0:04:08	0:00:27	0:01:32	0:00:21	0:05:20
Answer	A a	A a	C C	C c	C a	C c
TOTAL Time	0:07:16	0:18:18	0:06:31	0:08:47	0:07:29	0:15:52
TOTAL Wrong	1	2	0	0	4	1
HOS Rate	3	1	1	2	4	2
	NUMBER 13	NUMBER 14	NUMBER 15	NUMBER 16	NUMBER 17	NUMBER 18
JACKSON						
Othello Des.	0:00:34	0:03:00	0:01:22	0:00:37	0:01:49	0:02:56
JACK training	0:02:51	0:05:14	0:04:13	0:04:26	0:02:40	0:02:55
System Des.	0:00:34	0:00:43	0:00:32	0:00:51	0:00:43	0:00:50
Total Training	0:03:59	0:08:57	0:06:07	0:05:54	0:05:12	0:06:41
System	COUNTRY CLUB	PROJECT MANAGER	ADVISING	ADVISING	PROJECT MANAGER	COUNTRY CLUB
Seen JACK	no	no	yes	no	??	no
#1 Time	0:00:48	0:00:28	0:00:34	0:02:03	0:00:30	0:02:20
Answer	A a	C c	C C	C c	C c	A a
#2 Time	0:01:43	0:01:03	0:00:16	0:00:25	0:01:06	0:01:38
Answer	B b	A a	B A	B a	A a	B a
#3 Time	0:00:16	0:01:56	0:01:27	0:00:32	0:00:57	0:00:21
Answer	B b	C c	B B	B b	C c	B b
#4 Time	0:00:33	0:00:56	0:01:04	0:00:22	0:00:26	0:01:17
Answer	C c	B b	A A	A c	B b	C c
#5 Time	0:00:23	0:02:12	0:01:13	0:00:56	0:00:40	0:00:25
Answer	C c	A c	B B	B b	A a	C c
#6 Time	0:01:02	0:00:30	0:00:42	0:02:06	0:00:18	0:00:30
Answer	A a	B a	A A	A a	B a	A a
#7 Time	0:00:19	0:01:35	0:00:08	0:00:15	0:00:29	0:00:17
Answer	B b	A a	C C	C c	A a	B b
#8 Time	0:00:41	0:01:28	0:00:41	0:00:24	0:00:17	0:02:01
Answer	A b	A a	C C	C a	A a	A b
#9 Time	0:00:32	0:01:50	0:00:26	0:00:39	0:01:59	0:01:26
Answer	B b	B c	B C	B c	B c	B b
#10 Time	0:00:20	0:01:31	0:01:03	0:00:59	0:00:53	0:00:48
Answer	C c	C c	A A	A a	C b	C b
TOTAL Time	0:06:37	0:13:29	0:07:34	0:08:43	0:07:35	0:11:03
TOTAL Wrong	1	3	2	4	3	3
JACK Rate	2	3	1	2	2	2

	NUMBER 13	NUMBER 14	NUMBER 15	NUMBER 16	NUMBER 17	NUMBER 18
WARNIER-ORR						
Othello Des.	0:00:27	0:05:54	0:00:14	0:01:06	0:03:23	0:03:29
WO training	0:05:44	0:08:53	0:06:18	0:06:45	0:03:46	0:06:55
System Des.	0:00:58	0:02:03	0:00:42	0:00:37	0:02:09	0:01:56
Total Training	0:07:09	0:16:50	0:07:14	0:08:28	0:09:18	0:12:20
System	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT
Seen WO	no	no	yes	no	no	yes
#1 Time	0:01:01	0:00:43	0:01:11	0:02:34	0:00:36	0:00:52
Answer	B c	B b	B B	B b	B b	B b
#2 Time	0:00:34	0:02:01	0:01:40	0:00:58	0:01:53	0:01:17
Answer	A a	A a	A A	A a	A a	A a
#3 Time	0:01:09	0:02:09	0:01:20	0:01:09	0:00:46	0:01:10
Answer	B a	B a	B B	B b	B b	B b
#4 Time	0:00:53	0:00:50	0:02:00	0:00:39	0:00:23	0:01:13
Answer	D b	D d	D A	D d	D b	D b
#5 Time	0:01:08	0:04:54	0:01:21	0:02:49	0:01:29	0:03:57
Answer	B c	B c	B C	B	B a	B c
#6 Time	0:02:03	0:01:11	0:00:46	0:01:50	0:00:28	0:01:23
Answer	B b	B b	B B	B b	B b	B b
#7 Time	0:00:20	0:02:20	0:00:34	0:00:37	0:00:32	0:01:58
Answer	C c	C c	C C	C c	C c	C c
#8 Time	0:00:57	0:01:19	0:01:15	0:00:41	0:00:46	0:02:46
Answer	B b	B b	B A	B b	B c	B a
#9 Time	0:00:15	0:00:58	0:00:42	0:00:43	0:01:01	0:00:21
Answer	B b	B b	B B	B b	B b	B b
#10 Time	0:00:19	0:00:30	0:00:10	0:00:38	0:00:26	0:00:15
Answer	C c	C c	C C	C c	C c	C c
TOTAL Time	0:08:39	0:16:55	0:10:59	0:12:38	0:08:20	0:15:12
TOTAL Wrong	4	2	3	1	3	3
WO Rate	3	2	2	2	3	4
	NUMBER 13	NUMBER 14	NUMBER 15	NUMBER 16	NUMBER 17	NUMBER 18
YOURDON-CONSTANTINE						
Othello Des.	0:00:32	0:00:43	0:02:14	0:02:15	0:01:12	0:02:51
YC training	0:02:30	0:06:42	0:02:40	0:02:18	0:04:39	0:04:17
System Des.	0:00:59	0:00:32	0:00:51	0:00:35	0:01:15	0:01:34
Total Training	0:04:01	0:07:57	0:05:45	0:05:08	0:07:06	0:08:42
System	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	ADVISING	ADVISING
Seen YC	no	no	yes	no	no	yes
#1 Time	0:00:47	0:01:52	0:02:17	0:01:10	0:02:48	0:01:53
Answer	C a	A a	C A	A a	C c	C c
#2 Time	0:00:31	0:03:29	0:00:25	0:00:53	0:00:25	0:02:09
Answer	A a	B b	A A	B a	B a	B a
#3 Time	0:00:10	0:01:39	0:00:42	0:01:10	0:00:41	0:02:15
Answer	C c	B b	C B	B b	B b	B b
#4 Time	0:00:36	0:02:12	0:01:01	0:01:14	0:00:25	0:01:32
Answer	B b	C a	B C	C c	A c	A a
#5 Time	0:00:33	0:00:27	0:00:17	0:01:15	0:00:39	0:00:36
Answer	A c	C c	A A	C c	B b	B b
#6 Time	0:00:26	0:01:16	0:01:28	0:00:25	0:00:55	0:01:11
Answer	B a	A a	B B	A a	A a	A a
#7 Time	0:00:20	0:01:23	0:00:28	0:00:19	0:00:13	0:00:12
Answer	A a	B b	A A	B b	C c	C c
#8 Time	0:00:10	0:01:15	0:01:01	0:01:10	0:00:22	0:01:17
Answer	A a	A a	A A	A a	C c	C c
#9 Time	0:01:35	0:01:41	0:01:44	0:00:25	0:00:40	0:00:31
Answer	B b	B b	B B	B b	B c	B b
#10 Time	0:00:37	0:01:28	0:00:23	0:00:22	0:00:24	0:00:41
Answer	C c	C a	C C	C c	A a	A a
TOTAL Time	0:05:45	0:16:42	0:09:46	0:08:23	0:07:32	0:12:17
TOTAL Wrong	3	2	3	1	3	1
YC Rate	5	3	2	2	5	3
Diagram Choice	jackson	HOS	jackson	HOS	yordan-constantine	HOS
Courses Taking	CS420	CS420	CS690	CS300	cs420	CS420
	CS561	CS561				

	NUMBER 19	NUMBER 20	NUMBER 21	NUMBER 22	NUMBER 23	NUMBER 24
HOS						
Othello Des.	0:00:44	0:01:03	0:00:15	0:01:30	0:00:30	0:00:03
HOS training	0:06:07	0:02:33	0:04:53	0:02:38	0:04:39	0:04:35
System Des.	0:00:56	0:00:37	0:00:13	0:00:52	0:00:32	0:01:17
Total Training	0:07:47	0:04:13	0:05:21	0:05:00	0:05:41	0:05:55
System	ADVISING	ADVISING	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER
Seen HOS	no	no	no	no	no	no
#1 Time	0:01:34	0:00:48	0:01:21	0:01:08	0:00:43	0:00:46
Answer	C c	C c	A A	C c	A a	C c
#2 Time	0:00:13	0:00:42	0:01:03	0:01:15	0:01:28	0:00:53
Answer	B b	B a	B A	A a	B a	A a
#3 Time	0:00:49	0:00:39	0:00:50	0:01:12	0:00:23	0:00:39
Answer	B b	B b	B B	C c	B b	C c
#4 Time	0:00:58	0:00:41	0:01:30	0:00:34	0:00:30	0:00:08
Answer	A b	A b	C C	B b	C c	B b
#5 Time	0:01:10	0:00:18	0:00:17	0:00:52	0:00:28	0:00:18
Answer	B b	B b	C C	A a	C c	A a
#6 Time	0:00:56	0:00:37	0:00:59	0:00:16	0:00:18	0:00:30
Answer	A a	A a	A A	B b	A a	B a
#7 Time	0:00:38	0:01:26	0:00:51	0:00:17	0:00:19	0:00:25
Answer	C c	C c	B A	A a	B b	A a
#8 Time	0:01:05	0:00:38	0:00:32	0:00:21	0:01:02	0:00:19
Answer	C a	C c	A B	A a	A a	A a
#9 Time	0:00:17	0:00:47	0:00:48	0:00:24	0:00:28	0:00:42
Answer	B b	B c	B B	B b	B b	B b
#10 Time	0:01:15	0:01:24	0:00:36	0:01:06	0:00:33	0:00:51
Answer	A a	A a	C A	C c	C c	C c
TOTAL Time	0:08:55	0:08:00	0:08:47	0:07:25	0:06:12	0:05:31
TOTAL Wrong	2	3	4	0	1	1
HOS Rate	1	2	2	2	1	1
	NUMBER 19	NUMBER 20	NUMBER 21	NUMBER 22	NUMBER 23	NUMBER 24
JACKSON						
Othello Des.	0:00:28	0:00:44	0:00:18	0:00:20	0:00:27	0:00:03
JACK training	0:04:13	0:00:40	0:04:10	0:03:16	0:03:38	0:03:49
System Des.	0:00:57	0:00:36	0:00:35	0:00:56	0:00:52	0:00:40
Total Training	0:05:38	0:02:00	0:05:03	0:04:32	0:04:57	0:04:32
System	COUNTRY CLUB	PROJECT MANAGER	ADVISING	ADVISING	PROJECT MANAGER	COUNTRY CLUB
Seen JACK	no	no	no	no	no	no
#1 Time	0:01:52	0:00:43	0:00:58	0:00:53	0:00:20	0:01:36
Answer	A a	C c	C C	C b	C c	A a
#2 Time	0:00:59	0:00:16	0:00:31	0:01:46	0:01:11	0:01:18
Answer	B b	A a	B A	B b	A a	B b
#3 Time	0:00:26	0:00:46	0:01:02	0:00:37	0:00:58	0:00:26
Answer	B b	C c	B B	B b	C c	B b
#4 Time	0:00:29	0:01:04	0:00:42	0:00:17	0:01:12	0:00:40
Answer	C c	B b	A C	A a	B b	C c
#5 Time	0:00:59	0:01:00	0:00:27	0:00:17	0:00:23	0:00:12
Answer	C c	A a	B B	B a	A a	C c
#6 Time	0:00:25	0:00:14	0:00:58	0:00:44	0:00:34	0:01:27
Answer	A a	B a	A B	A a	B b	A a
#7 Time	0:00:13	0:00:14	0:00:24	0:00:13	0:01:11	0:00:22
Answer	B b	A a	C C	C c	A a	B b
#8 Time	0:01:20	0:00:25	0:00:25	0:00:32	0:00:19	0:00:58
Answer	A a	A a	C B	C c	A a	A a
#9 Time	0:00:55	0:00:58	0:00:42	0:00:23	0:00:57	0:00:40
Answer	B b	B b	B C	B b	B b	B b
#10 Time	0:00:23	0:00:29	0:00:28	0:00:38	0:00:19	0:00:16
Answer	C c	C c	A A	A a	C a	C c
TOTAL Time	0:08:01	0:06:09	0:06:37	0:06:20	0:07:24	0:07:55
TOTAL Wrong	0	1	5	2	1	0
JACK Rate	2	1	2	2	2	1

	NUMBER 19	NUMBER 20	NUMBER 21	NUMBER 22	NUMBER 23	NUMBER 24
WARNIER-ORR						
Othello Des.	0:00:26	0:00:54	0:00:22	0:00:21	0:00:51	0:00:17
WO training	0:05:16	0:02:50	0:03:20	0:03:44	0:05:24	0:04:41
System Des.	0:01:29	0:00:47	0:00:16	0:00:54	0:01:05	0:01:32
Total Training	0:07:11	0:04:31	0:03:58	0:04:59	0:07:20	0:06:30
System	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	ADVISING	ADVISING
Seen WO	no	no	no	yes	no	no
#1 Time	0:01:23	0:00:36	0:01:02	0:00:29	0:01:34	0:01:24
Answer	C c	A a	C C	A a	C c	C c
#2 Time	0:00:24	0:01:06	0:00:20	0:02:11	0:00:54	0:01:09
Answer	A a	B c	A A	B b	B c	B c
#3 Time	0:02:20	0:00:52	0:00:26	0:00:27	0:01:59	0:00:35
Answer	C c	B b	C C	B b	B b	B b
#4 Time	0:00:21	0:01:35	0:00:22	0:00:23	0:00:25	0:00:10
Answer	B b	C c	B B	C c	A a	A a
#5 Time	0:00:34	0:00:24	0:00:37	0:00:21	0:00:24	0:00:26
Answer	A a	C c	A A	C c	B b	B a
#6 Time	0:02:16	0:00:12	0:00:11	0:00:38	0:01:21	0:00:30
Answer	B b	A a	B B	A a	A c	A a
#7 Time	0:00:12	0:00:20	0:00:13	0:00:32	0:00:35	0:00:18
Answer	A a	B b	A B	B b	C c	C c
#8 Time	0:00:14	0:00:30	0:00:13	0:00:36	0:00:40	0:00:25
Answer	A a	A c	A A	A a	C c	C c
#9 Time	0:00:34	0:01:28	0:00:17	0:00:50	0:00:41	0:00:23
Answer	B b	B b	B A	B b	B b	B b
#10 Time	0:00:59	0:00:38	0:00:41	0:01:34	0:00:14	0:00:56
Answer	C c	C c	C A	C a	A c	A a
TOTAL Time	0:09:17	0:07:41	0:04:22	0:08:01	0:08:47	0:06:16
TOTAL Wrong	0	2	3	0	3	2
WO Rate	3	1	2	2	3	2
	NUMBER 19	NUMBER 20	NUMBER 21	NUMBER 22	NUMBER 23	NUMBER 24
YOURDON-CONSTANTINE						
Othello Des.	0:01:06	0:00:53	0:01:26	0:03:45	0:00:41	0:01:38
YC training	0:06:32	0:04:47	0:02:46	0:03:02	0:04:37	0:04:31
System Des.	0:01:06	0:00:33	0:00:24	0:01:09	0:00:22	0:01:11
Total Training	0:08:44	0:06:13	0:04:36	0:07:56	0:05:40	0:07:20
System	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT
Seen YC	no	no	no	no	no	no
#1 Time	0:01:42	0:00:17	0:00:47	0:00:52	0:00:29	0:01:12
Answer	B b	B b	B B	B b	B b	B b
#2 Time	0:01:49	0:00:44	0:01:08	0:00:50	0:00:26	0:00:35
Answer	A a	A a	A A	A a	A c	A a
#3 Time	0:01:00	0:00:27	0:00:40	0:01:24	0:02:00	0:01:22
Answer	B b	B a	B A	B a	B b	B c
#4 Time	0:00:46	0:00:24	0:00:19	0:01:01	0:01:27	0:00:32
Answer	D b	D b	D A	D d	D d	D a
#5 Time	0:00:50	0:01:42	0:00:27	0:00:42	0:01:25	0:01:06
Answer	B b	B b	B B	B b	B b	B b
#6 Time	0:00:26	0:00:36	0:00:42	0:00:28	0:01:34	0:00:37
Answer	A a	A c	A C	A a	A a	A a
#7 Time	0:01:21	0:00:09	0:00:37	0:00:23	0:00:29	0:00:37
Answer	C c	C c	C C	C c	C c	C c
#8 Time	0:00:29	0:00:18	0:00:17	0:00:34	0:01:15	0:00:37
Answer	B e	B r	B C	B question scrolled	B b	B b
#9 Time	0:00:33	0:00:20	0:00:46	0:00:26	0:00:11	0:00:19
Answer	C c	C c	C C	C c	C c	C b
#10 Time	0:00:14	0:00:24	0:00:13	0:00:24	0:00:18	0:00:14
Answer	C c	C c	C C	C c	C c	C c
TOTAL Time	0:09:10	0:05:21	0:05:56	0:07:04	0:09:34	0:07:11
TOTAL Wrong	2	4	4	1	1	3
YC Rate	3	2	3	2	2	2
Diagram Choice	HOS	JACKSON	WARNIER-ORR	Warnier-Orr	HOS	hos
Courses Taking	cs420	CS300	cs420	CS420	cs561	CS300
	CS420			CS300		

Professional Spreadsheet Data

	NUMBER 1	NUMBER 2	NUMBER 3	NUMBER 4	NUMBER 5	NUMBER 6
HOS						
Othello Des.	0:04:07	0:00:42	0:00:58	0:00:46	0:01:17	0:02:54
HOS training	0:05:54	0:06:23	0:08:25	0:04:05	0:05:21	0:10:02
System Des.	0:01:21	0:01:08	0:00:43	0:01:06	0:00:49	0:00:31
Total Training	0:11:22	0:08:13	0:10:06	0:05:57	0:07:27	0:13:27
System	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT
Seen HOS	yes	yes	yes	yes	yes	yes
#1 Time	0:04:05	0:02:09	0:00:48	0:01:13	0:01:44	0:03:49
Answer	B c	B c	B b	B c	B B	B B
#2 Time	0:01:40	0:02:04	0:00:32	0:00:22	0:01:42	0:01:13
Answer	A b	A b	A A	A a	A A	A A
#3 Time	0:02:43	0:01:13	0:01:00	0:00:40	0:01:10	0:01:13
Answer	B b	B a	B A	B b	B B	B B
#4 Time	0:03:05	0:00:58	0:01:04	0:00:51	0:01:12	0:01:21
Answer	D d	D b	D B	D d	D A	D C
#5 Time	0:00:42	0:01:14	0:01:09	0:00:25	0:00:54	0:00:53
Answer	B b	B c	B B	B b	B B	B B
#6 Time	0:01:05	0:01:26	0:00:57	0:00:37	0:02:09	0:01:48
Answer	B b	B b	B C	B b	B B	B B
#7 Time	0:01:24	0:01:03	0:00:39	0:00:24	0:00:22	0:00:47
Answer	C c	C c	C C	C c	C C	C C
#8 Time	0:01:08	0:01:07	0:00:37	0:00:55	0:01:04	0:01:31
Answer	B b	B b	B B	B b	B B	B B
#9 Time	0:00:17	0:01:19	0:00:22	0:00:16	0:00:23	0:00:28
Answer	B b	B b	B B	B b	B B	B B
#10 Time	0:00:48	0:00:45	0:00:22	0:00:08	0:00:13	0:00:28
Answer	C c	C c	C C	C c	C C	C C
TOTAL Time	0:16:58	0:13:18	0:07:30	0:05:51	0:10:53	0:13:31
TOTAL Wrong	2	5	3	1	1	1
HOS Rate	2	2	3	1	3	3
	NUMBER 1	NUMBER 2	NUMBER 3	NUMBER 4	NUMBER 5	NUMBER 6
JACKSON						
Othello Des.	0:03:11	0:02:42	0:00:37	0:02:01	0:00:35	0:00:20
JACK training	0:04:19	0:04:36	0:02:57	0:02:09	0:03:39	0:03:32
System Des.	0:01:59	0:01:03	0:01:06	0:01:35	0:00:23	0:00:19
Total Training	0:09:29	0:08:21	0:04:40	0:05:45	0:04:37	0:04:11
System	ADVISING	ADVISING	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER
Seen JACK	yes	no	yes	no	no	yes
#1 Time	0:00:56	0:01:44	0:00:43	0:00:25	0:00:33	0:00:58
Answer	C c	C c	A a	C c	A A	C C
#2 Time	0:01:09	0:02:48	0:00:24	0:00:32	0:01:07	0:01:34
Answer	B b	B a	B b	A a	B B	A C
#3 Time	0:01:47	0:02:17	0:00:26	0:00:50	0:00:21	0:00:37
Answer	B b	B b	B B	C c	B B	C C
#4 Time	0:00:25	0:00:38	0:00:33	0:00:27	0:00:30	0:02:06
Answer	A a	A a	C C	B b	C C	B B
#5 Time	0:00:55	0:00:45	0:00:33	0:00:16	0:01:09	0:00:56
Answer	B b	B b	C C	A a	C C	A A
#6 Time	0:00:42	0:01:13	0:00:15	0:00:23	0:00:40	0:00:51
Answer	A a	A a	A A	B b	A A	B B
#7 Time	0:00:16	0:00:50	0:00:24	0:00:16	0:00:14	0:00:34
Answer	C c	C c	B B	A a	B B	A A
#8 Time	0:01:08	0:01:10	0:00:37	0:00:12	0:01:07	0:00:33
Answer	C c	C c	A A	A a	A A	A B
#9 Time	0:00:50	0:00:31	0:00:58	0:00:23	0:00:49	0:01:33
Answer	B b	B b	B A	B b	B B	B C
#10 Time	0:01:03	0:00:56	0:00:26	0:00:27	0:00:38	0:00:53
Answer	A a	A a	C A	C c	C A	C C
TOTAL Time	0:09:11	0:12:52	0:05:19	0:04:11	0:07:08	0:10:35
TOTAL Wrong	0	1	2	0	1	3
JACK Rate	2	3	1	4	2	2

	NUMBER 1	NUMBER 2	NUMBER 3	NUMBER 4	NUMBER 5	NUMBER 6
WARNIER-ORR						
Othello Des.	0:03:38	0:00:22	0:00:50	0:00:57	0:00:23	0:00:24
WO training	0:04:56	0:06:18	0:05:22	0:06:31	0:04:11	0:05:11
System Des.	0:02:53	0:00:41	0:00:56	0:03:08	0:00:35	0:00:44
Total Training	0:11:27	0:07:21	0:07:08	0:10:36	0:05:09	0:06:19
System	COUNTRY CLUB	PROJECT MANAGER	ADVISING	ADVISING	PROJECT MANAGER	COUNTRY CLUB
Seen WO	yes	yes	yes	no	yes	yes
#1 Time	0:02:52	0:02:02	0:01:14	0:02:37	0:01:40	0:01:45
Answer	A a	C c	C c	C c	C C	A A
#2 Time	0:02:55	0:00:45	0:01:15	0:01:10	0:00:44	0:02:52
Answer	B a	A a	B a	B a	A A	B A
#3 Time	0:00:35	0:00:49	0:00:40	0:00:20	0:01:21	0:00:48
Answer	B b	C c	B b	B c	C C	B B
#4 Time	0:01:26	0:00:33	0:00:10	0:00:55	0:00:29	0:01:07
Answer	C c	B b	A a	A a	B B	C A
#5 Time	0:00:22	0:01:09	0:00:20	0:00:43	0:00:39	0:00:38
Answer	C c	A a	B b	B b	A A	C C
#6 Time	0:01:53	0:00:56	0:01:21	0:00:42	0:00:54	0:01:03
Answer	A a	B b	A a	A a	B B	A A
#7 Time	0:00:27	0:00:39	0:00:10	0:00:11	0:00:17	0:02:02
Answer	B b	A a	C c	C c	A A	B B
#8 Time	0:01:05	0:00:48	0:01:04	0:00:53	0:00:18	0:00:51
Answer	A a	A a	C a	C a	A A	A B
#9 Time	0:01:32	0:00:24	0:00:10	0:00:36	0:00:19	0:01:57
Answer	B b	B b	B b	B c	B B	B B
#10 Time	0:01:13	0:02:06	0:01:01	0:00:59	0:02:16	0:01:23
Answer	C c	C c	A a	A a	C C	C A
TOTAL Time	0:14:20	0:10:11	0:07:25	0:09:06	0:08:57	0:14:26
TOTAL Wrong	1	0	2	4	0	4
WO Rate	3	2	2	3	3	4
	NUMBER 1	NUMBER 2	NUMBER 3	NUMBER 4	NUMBER 5	NUMBER 6
YOURDON-CONSTANTINE						
Othello Des.	0:00:43	0:00:23	0:00:39	0:08:17	0:00:40	0:00:22
YC training	0:04:37	0:05:54	0:03:36	0:02:19	0:04:47	0:04:35
System Des.	0:00:58	0:00:46	0:00:43	0:01:17	0:00:44	0:02:00
Total Training	0:06:18	0:07:03	0:04:58	0:11:53	0:06:11	0:06:57
System	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	ADVISING	ADVISING
Seen YC	yes	yes	yes	no	yes	yes
#1 Time	0:01:05	0:02:14	0:00:34	0:00:42	0:01:33	0:02:57
Answer	C c	A a	C C	A a	C C	C C
#2 Time	0:00:51	0:02:50	0:00:06	0:01:04	0:02:01	0:01:21
Answer	A a	B a	A A	B a	B A	B A
#3 Time	0:00:38	0:01:22	0:01:44	0:00:27	0:01:02	0:01:19
Answer	C c	B b	C C	B b	B B	B B
#4 Time	0:01:34	0:01:20	0:00:24	0:00:49	0:00:26	0:00:45
Answer	B b	C c	B B	C c	A A	A A
#5 Time	0:00:41	0:00:20	0:00:27	0:00:28	0:00:28	0:00:51
Answer	A a	C c	A A	C c	B A	B B
#6 Time	0:00:28	0:00:55	0:00:33	0:00:17	0:00:36	0:01:44
Answer	B a	A a	B A	A a	A A	A A
#7 Time	0:00:59	0:00:25	0:00:15	0:00:24	0:00:11	0:00:35
Answer	A a	B b	A B	B b	C C	C C
#8 Time	0:00:46	0:01:26	0:00:23	0:01:18	0:00:21	0:00:56
Answer	A a	A b	A A	A b	C B	C C
#9 Time	0:01:35	0:01:13	0:02:53	0:00:55	0:00:36	0:00:49
Answer	B b	B b	B C	B a	B C	B C
#10 Time	0:00:15	0:00:33	0:00:36	0:00:23	0:00:37	0:00:58
Answer	C c	C c	C C	C c	A A	A A
TOTAL Time	0:08:52	0:12:38	0:07:55	0:06:47	0:07:51	0:12:15
TOTAL Wrong	1	2	3	3	4	2
YC Rate	3	3	5	2	4	2
Diagram Choice	HOS	hos	JACKSON	HOS	JACKSON	Yordon-constatine
Courses Taking	cs690	????	cs761	none	cs630	????
	cs897				cs761	
	cs898					

	NUMBER 7	NUMBER 8	NUMBER 9	NUMBER 10	NUMBER 11	NUMBER 12
HOS						
Othello Des.	0:00:50	0:03:06	0:00:12	0:00:59	0:00:11	0:02:45
HOS training	0:05:35	0:02:57	0:03:08	0:03:03	0:05:00	0:03:59
System Des.	0:00:41	0:00:26	0:00:49	0:00:24	0:00:45	0:00:45
Total Training	0:07:06	0:06:29	0:04:09	0:04:26	0:05:56	0:07:29
System	ADVISING	ADVISING	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER
Seen HOS	no	no	no	no	yes	yes
#1 Time	0:00:59	0:00:20	0:00:40	0:00:23	0:01:32	0:01:37
Answer	C c	C a	A a	C c	A a	C C
#2 Time	0:00:29	0:00:15	0:00:46	0:00:21	0:02:52	0:00:16
Answer	B a	B b	B a	A a	B b	A C
#3 Time	0:00:42	0:00:28	0:00:39	0:00:43	0:00:22	0:00:34
Answer	B b	B b	B b	C c	B b	C C
#4 Time	0:00:47	0:00:20	0:00:44	0:00:37	0:00:46	0:00:30
Answer	A c	A a	C c	B b	C c	B A
#5 Time	0:00:23	0:00:09	0:00:24	0:00:21	0:00:16	0:00:30
Answer	B b	B b	C c	A a	C c	A A
#6 Time	0:00:30	0:00:54	0:00:30	0:00:12	0:00:20	0:00:58
Answer	A a	A a	A b	B b	A a	B B
#7 Time	0:00:27	0:00:14	0:00:50	0:00:12	0:00:11	0:00:33
Answer	C c	C a	B b	A a	B b	A A
#8 Time	0:00:33	0:00:25	0:00:35	0:00:11	0:01:06	0:00:20
Answer	C c	C a	A b	A a	A b	A A
#9 Time	0:00:16	0:00:08	0:00:40	0:00:13	0:00:29	0:00:31
Answer	B b	B b	B c	B b	B b	B B
#10 Time	0:01:45	0:00:32	0:00:40	0:00:28	0:00:26	0:00:45
Answer	A a	A b	C a	C c	C c	C C
TOTAL Time	0:06:51	0:03:45	0:06:28	0:03:41	0:08:20	0:06:34
TOTAL Wrong	2	4	5	0	1	2
HOS Rate	2	5	3	2	2	2
	NUMBER 7	NUMBER 8	NUMBER 9	NUMBER 10	NUMBER 11	NUMBER 12
JACKSON						
Othello Des.	0:00:48	0:01:47	0:02:58	0:00:38	0:01:05	0:01:38
JACK training	0:04:05	0:04:39	0:03:52	0:02:06	0:04:35	0:04:47
System Des.	0:00:31	0:00:30	0:00:57	0:00:45	0:01:10	0:01:11
Total Training	0:05:24	0:06:56	0:07:47	0:03:29	0:06:50	0:07:36
System	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVING ACCOUNT	SAVINGS ACCOUNT
Seen JACK	no	no	no	no	yes	yes
#1 Time	0:01:28	0:01:26	0:01:16	0:00:48	0:00:36	0:01:23
Answer	B c	B b	B b	B b	B b	B B
#2 Time	0:01:31	0:01:24	0:00:49	0:00:39	0:01:02	0:00:56
Answer	A b	A a	A a	A a	A a	A A
#3 Time	0:00:57	0:00:45	0:01:28	0:01:38	0:01:36	0:01:10
Answer	B a	B b	B a	B c	B b	B B
#4 Time	0:00:32	0:00:20	0:00:19	0:00:16	0:00:39	0:01:25
Answer	D b	D b	D a	D a	D d	D D
#5 Time	0:00:36	0:00:53	0:00:10	0:00:47	0:01:19	0:01:48
Answer	B b	B c	B b	B c	B b	B B
#6 Time	0:01:35	0:00:18	0:00:06	0:01:25	0:01:12	0:01:04
Answer	B c	B c	B c	B c	B b	B B
#7 Time	0:00:15	0:01:23	0:00:07	0:00:51	0:00:26	0:00:24
Answer	C c	C a	C b	C c	C c	C C
#8 Time	0:00:24	0:00:23	0:00:17	0:00:29	0:00:22	0:00:40
Answer	B b	B b	B c	B b	B b	B B
#9 Time	0:01:29	0:00:27	0:00:21	0:00:17	0:00:48	0:00:23
Answer	B b	B b	B c	B b	B b	B B
#10 Time	0:00:21	0:00:27	0:00:21	0:00:22	0:00:24	0:00:22
Answer	C c	C c	C c	C c	C c	C C
TOTAL Time	0:09:08	0:07:48	0:05:14	0:07:32	0:08:24	0:09:35
TOTAL Wrong	5	4	6	4	0	0
JACK Rate	3	2	3	4	3	2

	NUMBER 7	NUMBER 8	NUMBER 9	NUMBER 10	NUMBER 11	NUMBER 12
WARNIER-ORR						
Othello Des.	0:00:50	0:01:52	0:00:27	0:00:38	0:00:08	0:00:23
WO training	0:05:45	0:01:26	0:02:39	0:03:06	0:05:41	0:05:34
System Des.	0:00:39	0:01:21	0:01:08	0:00:35	0:00:37	0:00:32
Total Training	0:07:14	0:04:39	0:04:14	0:04:19	0:06:26	0:06:29
System	COUNTRY CLUB	PROJECT MANAGER	ADVISING	ADVISING	PROJECT MANAGER	COUNTRY CLUB
Seen WO	no	no	no	no	yes	yes
#1 Time	0:01:09	0:00:48	0:00:16	0:01:10	0:00:57	0:01:16
Answer	A a	C c	C c	C c	C c	A A
#2 Time	0:01:20	0:00:21	0:00:41	0:01:55	0:00:37	0:01:08
Answer	B a	A a	B a	B a	A a	B A
#3 Time	0:00:21	0:01:44	0:00:42	0:00:38	0:00:34	0:00:47
Answer	B b	C c	B c	B b	C c	B B
#4 Time	0:01:15	0:00:36	0:00:48	0:00:10	0:00:40	0:00:49
Answer	C c	B b	A a	A a	B b	C C
#5 Time	0:00:23	0:00:26	0:00:13	0:00:13	0:01:14	0:00:15
Answer	C c	A b	B b	B b	A a	C C
#6 Time	0:00:23	0:00:17	0:00:38	0:00:53	0:00:45	0:00:12
Answer	A a	B b	A b	A b	B b	A C
#7 Time	0:00:20	0:00:18	0:00:17	0:00:26	0:00:27	0:00:40
Answer	B a	A a	C c	C c	A a	B A
#8 Time	0:00:31	0:00:14	0:00:24	0:00:30	0:00:28	0:00:42
Answer	A a	A a	C c	C c	A a	A B
#9 Time	0:00:31	0:00:33	0:00:33	0:00:44	0:00:25	0:00:58
Answer	B b	B b	B b	B b	B b	B B
#10 Time	0:00:37	0:00:28	0:00:40	0:00:36	0:01:40	0:00:35
Answer	C c	C c	A b	A a	C c	C C
TOTAL Time	0:06:50	0:05:45	0:05:12	0:07:15	0:07:47	0:07:22
TOTAL Wrong	2	1	4	2	0	4
WO Rate	4	3	4	4	3	3
	NUMBER 7	NUMBER 8	NUMBER 9	NUMBER 10	NUMBER 11	NUMBER 12
YOURDON-CONSTANTINE						
Othello Des.	0:00:31	0:02:09	0:00:36	0:00:16	0:00:28	0:00:39
YC training	0:04:22	0:01:18	0:02:07	0:02:27	0:04:28	0:04:57
System Des.	0:00:49	0:00:35	0:00:45	0:00:26	0:00:51	0:00:45
Total Training	0:05:42	0:04:02	0:03:28	0:03:09	0:05:47	0:06:21
System	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	ADVISING	ADVISING
Seen YC	no	no	no	yes	yes	yes
#1 Time	0:00:47	0:00:36	0:00:47	0:00:29	0:01:44	0:04:40
Answer	C c	A c	C c	A b	C c	C B
#2 Time	0:00:40	0:00:37	0:00:18	0:00:25	0:00:51	0:00:45
Answer	A a	B a	A c	B a	B a	B A
#3 Time	0:00:24	0:00:39	0:00:19	0:00:39	0:02:30	0:00:58
Answer	C c	B b	C b	B b	B c	B B
#4 Time	0:00:59	0:00:45	0:00:28	0:00:51	0:00:49	0:00:49
Answer	B a	C b	B b	C b	A a	A A
#5 Time	0:00:41	0:00:25	0:00:28	0:00:11	0:00:42	0:00:14
Answer	A a	C c	A a	C c	B b	B B
#6 Time	0:00:38	0:00:17	0:00:31	0:00:34	0:00:24	0:00:41
Answer	B a	A a	B b	A a	A a	A A
#7 Time	0:00:33	0:00:11	0:00:32	0:00:04	0:00:10	0:00:34
Answer	A b	B b	A a	B b	C c	C C
#8 Time	0:00:17	0:00:33	0:00:25	0:00:23	0:00:50	0:00:47
Answer	A a	A a	A a	A a	C b	C A
#9 Time	0:00:25	0:00:19	0:00:51	0:00:24	0:00:21	0:00:48
Answer	B b	B b	B c	B b	B c	B B
#10 Time	0:00:13	0:00:14	0:00:36	0:00:12	0:00:35	0:00:20
Answer	C c	C c	C c	C c	A a	A A
TOTAL Time	0:05:37	0:04:36	0:05:15	0:04:12	0:08:56	0:10:36
TOTAL Wrong	3	3	3	3	4	3
YC Rate	3	3	3	3	4	4
Diagram Choice	jackson	jackson	HOS	hos	hos	HOS
Courses Taking	cs700	cs700	????	????	cs700	cs700
	cs720	cs761			cs720	cs720

	NUMBER 13	NUMBER 14	NUMBER 15	NUMBER 16	NUMBER 17	NUMBER 18
HOS						
Othello Des.	0:01:06	0:00:21	0:00:33	0:02:05	0:01:33	0:03:09
HOS training	0:05:50	0:05:26	0:07:41	0:05:42	0:08:43	0:02:15
System Des.	0:01:03	0:00:41	0:00:34	0:00:48	0:00:44	0:00:31
Total Training	0:07:59	0:06:28	0:08:48	0:08:35	0:11:00	0:05:55
System	ADVISING	ADVISING	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER
Seen HOS	no	yes	yes	no	no	no
#1 Time	0:01:05	0:00:29	0:02:31	0:00:34	0:01:41	0:02:04
Answer	C c	C c	A a	C c	A b	C a
#2 Time	0:00:32	0:01:04	0:01:31	0:01:37	0:02:16	0:01:22
Answer	B b	B a	B b	A a	B b	A a
#3 Time	0:01:23	0:00:20	0:00:46	0:01:43	0:00:22	0:01:02
Answer	B b	B b	B b	C c	B b	C c
#4 Time	0:00:36	0:00:09	0:00:42	0:00:14	0:01:20	0:00:42
Answer	A c	A a	C c	B b	C c	B b
#5 Time	0:01:14	0:00:06	0:01:17	0:00:41	0:00:27	0:01:17
Answer	B b	B b	C c	A a	C c	A a
#6 Time	0:02:03	0:00:29	0:00:21	0:01:19	0:00:28	0:00:45
Answer	A b	A a	A a	B a	A a	B b
#7 Time	0:00:23	0:00:48	0:00:29	0:00:23	0:00:30	0:00:48
Answer	C c	C a	B b	A a	B b	A a
#8 Time	0:00:22	0:00:52	0:00:48	0:01:26	0:01:19	0:00:20
Answer	C b	C c	A a	A a	A a	A a
#9 Time	0:00:36	0:00:39	0:00:48	0:00:24	0:00:32	0:00:24
Answer	B c	B b	B b	B b	B b	B b
#10 Time	0:00:33	0:01:43	0:00:48	0:01:52	0:00:31	0:01:21
Answer	A a	A b	C c	C c	C c	C c
TOTAL Time	0:08:47	0:06:39	0:10:01	0:10:13	0:09:26	0:10:05
TOTAL Wrong	4	3	0	1	1	1
HOS Rate	4	2	3	2	2	3
	NUMBER 13	NUMBER 14	NUMBER 15	NUMBER 16	NUMBER 17	NUMBER 18
JACKSON						
Othello Des.	0:00:27	0:00:07	0:00:39	0:00:37	0:00:41	0:01:41
JACK training	0:03:56	0:03:57	0:04:20	0:04:43	0:03:54	0:03:30
System Des.	0:00:18	0:00:30	0:00:45	0:00:38	0:01:19	0:00:37
Total Training	0:04:41	0:04:34	0:05:44	0:05:58	0:05:54	0:05:48
System	COUNTRY CLUB	PROJECT MANAGER	ADVISING	ADVISING	PROJECT MANAGER	COUNTRY CLUB
Seen JACK	no	no	yes	no	yes	no
#1 Time	0:01:35	0:00:30	0:01:21	0:01:06	0:00:30	0:01:05
Answer	A b	C c	C c	C c	C c	A a
#2 Time	0:01:38	0:00:30	0:00:42	0:01:09	0:00:38	0:00:58
Answer	B a	A a	B b	B a	A a	B b
#3 Time	0:00:28	0:00:17	0:01:33	0:00:44	0:00:58	0:00:30
Answer	B b	C c	B b	B b	C c	B b
#4 Time	0:00:23	0:00:38	0:00:50	0:00:20	0:01:11	0:00:40
Answer	C a	B b	A a	A a	B b	C c
#5 Time	0:00:31	0:00:25	0:00:28	0:01:04	0:00:26	0:00:25
Answer	C c	A a	B b	B a	A a	C c
#6 Time	0:01:11	0:00:37	0:01:26	0:00:50	0:00:14	0:00:41
Answer	A a	B a	A a	A a	B b	A a
#7 Time	0:00:18	0:00:11	0:00:15	0:00:10	0:00:29	0:00:08
Answer	B b	A a	C c	C c	A a	B b
#8 Time	0:01:00	0:00:14	0:00:43	0:01:46	0:00:22	0:02:28
Answer	A a	A a	C a	C c	A a	A a
#9 Time	0:01:26	0:01:01	0:00:12	0:00:42	0:01:34	0:00:36
Answer	B b	B c	B b	B b	B c	B b
#10 Time	0:00:37	0:00:40	0:01:03	0:01:17	0:00:56	0:00:35
Answer	C a	C c	A a	A a	C c	C c
TOTAL Time	0:09:07	0:05:03	0:08:33	0:09:08	0:07:18	0:08:06
TOTAL Wrong	4	2	1	2	1	0
JACK Rate	2	3	3	2	2	2

	NUMBER 13	NUMBER 14	NUMBER 15	NUMBER 16	NUMBER 17	NUMBER 18
WARNIER-ORR						
Othello Des.	0:01:07	0:00:38	0:01:50	0:01:07	0:01:19	0:00:44
WO training	0:06:05	0:04:31	0:05:23	0:05:09	0:05:43	0:05:26
System Des.	0:00:29	0:00:26	0:01:10	0:00:29	0:00:38	0:00:26
Total Training	0:07:41	0:05:35	0:08:23	0:06:45	0:07:40	0:06:36
System	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT
Seen WO	no	no	yes	no	yes	no
#1 Time	0:00:18	0:00:47	0:01:28	0:00:23	0:01:37	0:04:15
Answer	B b	B a	B b	B b	B c	B b
#2 Time	0:00:46	0:01:21	0:01:14	0:01:18	0:00:37	0:01:41
Answer	A c	A b	A a	A a	A a	A b
#3 Time	0:00:59	0:00:50	0:01:15	0:00:52	0:01:58	0:01:04
Answer	B a	B b	B b	B a	B b	B b
#4 Time	0:00:13	0:00:43	0:00:35	0:01:32	0:01:04	0:01:44
Answer	D d	D a	D b	D a	D b	D d
#5 Time	0:01:45	0:01:13	0:01:37	0:02:16	0:01:01	0:00:37
Answer	B c	B c	B c	B c	B c	B c
#6 Time	0:01:09	0:00:44	0:00:26	0:01:04	0:00:57	0:00:52
Answer	B b	B b	B b	B a	B b	B a
#7 Time	0:00:40	0:00:44	0:00:17	0:00:22	0:00:56	0:01:07
Answer	C c	C c	C c	C c	C c	C c
#8 Time	0:00:56	0:00:21	0:01:42	0:00:42	0:02:29	0:03:26
Answer	B c	B b	B a	B c	B a	B b
#9 Time	0:00:45	0:00:13	0:00:39	0:00:43	0:00:30	0:00:16
Answer	B b	B b	B a	B b	B b	B b
#10 Time	0:00:41	0:00:17	0:00:15	0:00:20	0:00:35	0:00:17
Answer	C c	C c	C c	C c	C c	C c
TOTAL Time	0:08:12	0:07:13	0:09:28	0:09:32	0:11:44	0:15:19
TOTAL Wrong	4	4	4	5	4	3
WO Rate	2	4	5	4	5	3
	NUMBER 13	NUMBER 14	NUMBER 15	NUMBER 16	NUMBER 17	NUMBER 18
YOURDON-CONSTANTINE						
Othello Des.	0:00:09	0:00:09	0:00:30	0:00:31	0:00:41	0:01:18
YC training	0:05:29	0:03:09	0:07:49	0:06:04	0:06:07	0:03:44
System Des.	0:00:34	0:00:24	0:01:51	0:00:57	0:00:46	0:00:40
Total Training	0:06:12	0:03:42	0:10:10	0:07:32	0:07:34	0:05:42
System	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	ADVISING	ADVISING
Seen YC	no	no	yes	no	yes	no
#1 Time	0:00:19	0:00:52	0:02:43	0:01:38	0:01:59	0:02:44
Answer	C c	A c	C a	A a	C a	C b
#2 Time	0:01:04	0:00:49	0:00:38	0:02:22	0:02:36	0:01:54
Answer	A a	B a	A c	B b	B b	B b
#3 Time	0:01:48	0:00:56	0:00:44	0:01:32	0:01:40	0:01:33
Answer	C c	B b	C c	B b	B b	B b
#4 Time	0:00:49	0:00:46	0:00:58	0:00:23	0:00:37	0:00:34
Answer	B c	C a	B b	C a	A a	A a
#5 Time	0:00:41	0:00:15	0:00:27	0:00:39	0:00:36	0:01:53
Answer	A b	C c	A a	C c	B b	B b
#6 Time	0:00:52	0:00:12	0:00:27	0:00:27	0:02:22	0:00:41
Answer	B b	A a	B b	A c	A a	A a
#7 Time	0:00:28	0:00:12	0:00:28	0:00:20	0:00:18	0:00:08
Answer	A a	B b	A a	B b	C c	C c
#8 Time	0:00:39	0:00:34	0:00:25	0:00:59	0:01:46	0:01:12
Answer	A b	A a	A b	A b	C d	C b
#9 Time	0:01:17	0:00:35	0:02:26	0:00:38	0:00:21	0:00:31
Answer	B b	B b	B	B b	B c	B b
#10 Time	0:00:45	0:00:21	0:00:21	0:00:25	0:00:33	0:01:04
Answer	C c	C c	C c	C c	A a	A a
TOTAL Time	0:08:42	0:05:32	0:09:37	0:09:23	0:12:48	0:12:14
TOTAL Wrong	3	3	4	3	3	2
YC Rate	3	2	5	3	3	4
Diagram Choice	jackson	HOS	none	HOS	jackson	jackson
Courses Taking	????	cs700	cs630	cs700	graphics	graphics
		cs720	cs761	cs720		database

	NUMBER 19	NUMBER 20	NUMBER 21	NUMBER 22	NUMBER 23	NUMBER 24
HOS						
Othello Des.	0:00:37	0:00:57	0:00:21	0:00:36	0:00:17	0:00:28
HOS training	0:04:22	0:06:18	0:06:55	0:04:17	0:03:40	0:07:38
System Des.	0:00:35	0:00:08	0:00:34	0:00:27	0:00:40	0:00:38
Total Training	0:05:34	0:07:23	0:07:50	0:05:20	0:04:37	0:08:44
System	ADVISING	ADVISING	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER
Seen HOS	no	yes	yes	no	yes	yes
#1 Time	0:02:05	0:02:18	0:00:43	0:00:56	0:00:55	0:00:53
Answer	C c	C c	A a	C c	A a	C c
#2 Time	0:00:29	0:00:27	0:00:35	0:00:11	0:00:49	0:01:30
Answer	B a	B c	B b	A c	B b	A a
#3 Time	0:01:24	0:02:43	0:00:42	0:00:36	0:00:29	0:00:36
Answer	B b	B a	B b	C c	B b	C c
#4 Time	0:01:17	0:01:28	0:00:48	0:00:49	0:00:49	0:00:58
Answer	A c	A d	C c	B b	C c	B b
#5 Time	0:01:15	0:00:07	0:00:27	0:00:40	0:00:21	0:00:57
Answer	B b	B b	C c	A a	C c	A a
#6 Time	0:00:42	0:00:25	0:00:29	0:00:30	0:00:39	0:00:42
Answer	A a	A a	A a	B b	A a	B b
#7 Time	0:00:30	0:00:10	0:00:12	0:00:11	0:00:16	0:00:19
Answer	C c	C c	B b	A a	B a	A a
#8 Time	0:01:18	0:00:56	0:00:43	0:00:24	0:01:01	0:00:34
Answer	C c	C b	A a	A a	A a	A a
#9 Time	0:00:48	0:00:19	0:01:05	0:00:36	0:00:18	0:01:14
Answer	B c	B b	B b	B b	B b	B b
#10 Time	0:02:49	0:02:16	0:00:49	0:01:18	0:00:59	0:01:19
Answer	A b	A a	C c	C a	C b	C c
TOTAL Time	0:12:35	0:11:09	0:06:33	0:06:13	0:06:38	0:09:02
TOTAL Wrong	4	4	0	2	2	0
HOS Rate	3	3	1	5	2	3
	NUMBER 19	NUMBER 20	NUMBER 21	NUMBER 22	NUMBER 23	NUMBER 24
JACKSON						
Othello Des.	0:01:24	0:00:57	0:00:33	0:00:29	0:00:20	0:00:29
JACK training	0:03:07	0:03:42	0:03:28	0:02:33	0:03:42	0:04:33
System Des.	0:00:10	0:00:38	0:01:08	0:00:27	0:00:31	0:00:40
Total Training	0:04:41	0:05:17	0:05:09	0:03:29	0:04:33	0:05:42
System	COUNTRY CLUB	PROJECT MANAGER	ADVISING	ADVISING	PROJECT MANAGER	COUNTRY CLUB
Seen JACK	no	yes	yes	yes	yes	yes
#1 Time	0:01:03	0:00:27	0:00:36	0:01:03	0:00:44	0:01:21
Answer	A b	C c	C b	C b	C c	A a
#2 Time	0:01:24	0:00:53	0:00:19	0:00:32	0:00:19	0:00:55
Answer	B b	A a	B a	B a	A c	B a
#3 Time	0:02:05	0:01:14	0:00:45	0:00:30	0:00:29	0:00:17
Answer	B b	C c	B b	B c	C c	B b
#4 Time	0:00:19	0:01:14	0:00:17	0:01:33	0:00:33	0:01:45
Answer	C a	B b	A a	A b	B b	C c
#5 Time	0:00:18	0:00:46	0:00:13	0:00:08	0:00:33	0:00:44
Answer	C c	A a	B b	B a	A a	C c
#6 Time	0:00:13	0:00:31	0:00:48	0:00:29	0:00:14	0:01:03
Answer	A a	B b	A a	A a	B b	A a
#7 Time	0:00:56	0:00:52	0:00:14	0:00:07	0:00:11	0:00:27
Answer	B b	A b	C c	C c	A a	B b
#8 Time	0:01:46	0:00:43	0:00:30	0:00:26	0:00:10	0:01:31
Answer	A b	A a	C c	C c	A a	A a
#9 Time	0:00:52	0:02:03	0:00:18	0:00:44	0:00:31	0:00:38
Answer	B b	B c	B b	B b	B b	B b
#10 Time	0:00:18	0:01:15	0:00:36	0:01:12	0:01:34	0:00:26
Answer	C c	C c	A a	A a	C a	C c
TOTAL Time	0:09:14	0:09:58	0:04:36	0:06:44	0:05:18	0:09:07
TOTAL Wrong	3	2	2	5	2	1
JACK Rate	3	2	1	2	3	3

	NUMBER 19	NUMBER 20	NUMBER 21	NUMBER 22	NUMBER 23	NUMBER 24
WARNIER-ORR						
Othello Des.	0:00:39	0:03:06	0:00:24	0:01:07	0:00:21	0:00:39
WO training	0:02:23	0:03:32	0:03:48	0:02:31	0:04:10	0:07:51
System Des.	0:01:49	0:00:57	0:00:30	0:01:49	0:00:52	0:01:15
Total Training	0:04:51	0:07:35	0:04:42	0:05:27	0:05:23	0:09:45
System	PROJECT MANAGER	COUNTRY CLUB	PROJECT MANAGER	COUNTRY CLUB	ADVISING	ADVISING
Seen WO	yes	yes	yes	yes	yes	yes
#1 Time	0:00:27	0:01:42	0:00:41	0:01:25	0:01:58	0:01:47
Answer	C c	A a	C c	A a	C a	C c
#2 Time	0:01:43	0:01:27	0:00:48	0:01:38	0:01:05	0:00:53
Answer	A a	B b	A c	B b	B b	B a
#3 Time	0:00:35	0:01:03	0:00:26	0:00:27	0:00:25	0:02:47
Answer	C c	B b	C c	B b	B c	B b
#4 Time	0:00:19	0:00:19	0:00:25	0:00:43	0:00:51	0:00:37
Answer	B b	C c	B b	C a	A a	A a
#5 Time	0:00:12	0:00:46	0:00:12	0:00:11	0:00:21	0:00:41
Answer	A l	C c	A a	C c	B a	B b
#6 Time	0:00:39	0:00:26	0:00:32	0:00:25	0:00:51	0:01:02
Answer	B b	A a	B b	A a	A a	A a
#7 Time	0:00:32	0:00:39	0:00:09	0:00:18	0:00:20	0:00:17
Answer	A a	B a	A a	B b	C c	C c
#8 Time	0:00:10	0:01:16	0:00:09	0:00:17	0:00:17	0:00:56
Answer	A a	A a	A a	A a	C c	C b
#9 Time	0:00:12	0:00:30	0:00:20	0:00:20	0:00:19	0:00:55
Answer	B b	B b	B b	B b	B b	B b
#10 Time	0:00:25	0:00:34	0:00:57	0:00:23	0:00:51	0:01:52
Answer	C a	C c	C c	C a	A a	A a
TOTAL Time	0:05:14	0:08:42	0:04:39	0:06:07	0:07:18	0:11:47
TOTAL Wrong	2	1	1	2	3	2
WO Rate	4	3	5	4	3	3
	NUMBER 19	NUMBER 20	NUMBER 21	NUMBER 22	NUMBER 23	NUMBER 24
YOURDON-CONSTANTINE						
Othello Des.	0:00:49	0:00:51	0:00:56	0:02:56	0:00:52	0:00:55
YC training	0:06:57	0:03:59	0:06:24	0:04:03	0:03:29	0:05:50
System Des.	0:00:35	0:00:54	0:00:50	0:00:51	0:00:34	0:01:01
Total Training	0:08:21	0:05:44	0:08:10	0:07:50	0:04:55	0:07:46
System	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT	SAVINGS ACCOUNT
Seen YC	no	yes	yes	yes	yes	yes
#1 Time	0:00:56	0:01:18	0:02:38	0:00:58	0:01:08	0:02:08
Answer	B b	B b	B b	B c	B c	B a
#2 Time	0:00:58	0:01:19	0:01:01	0:00:44	0:00:48	0:03:07
Answer	A a	A a	A a	A b	A a	A a
#3 Time	0:01:28	0:04:29	0:01:22	0:00:51	0:01:20	0:01:19
Answer	B a	B c	B c	B c	B c	B c
#4 Time	0:00:49	0:00:23	0:00:35	0:00:18	0:00:18	0:02:04
Answer	D d	D a	D b	D a	D a	D a
#5 Time	0:00:45	0:00:53	0:00:35	0:00:58	0:00:29	0:03:07
Answer	B b	B b	B b	B b	B b	B b
#6 Time	0:00:55	0:00:52	0:00:33	0:00:29	0:00:22	0:00:38
Answer	A a	A a	A a	A a	A a	A a
#7 Time	0:00:39	0:01:11	0:00:53	0:00:30	0:00:27	0:00:29
Answer	C c	C c	C a	C c	C c	C c
#8 Time	0:00:22	0:00:22	0:00:20	0:00:27	0:00:28	0:00:34
Answer	B u	B e	B a	B c	B	B x
#9 Time	0:00:18	0:00:38	0:00:48	0:00:25	0:00:15	0:00:23
Answer	C c	C a	C c	C c	C c	C c
#10 Time	0:00:15	0:00:15	0:00:17	0:00:33	0:00:15	0:00:35
Answer	C c	C c	C c	C b	C c	C c
TOTAL Time	0:07:25	0:11:40	0:09:02	0:06:13	0:05:50	0:14:24
TOTAL Wrong	2	4	4	6	4	4
YC Rate	4	4	4	3	2	3
Diagram Choice	NONE	jackson	jackson	jackson	hos	jackson
Courses Taking	cs630	cs630	CS630	cs636	????	cs761
	cs636	cs780	CS890			cs630

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Student and Professional Understandability of Software Design Methodologies

by

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AN ABSTRACT OF A MASTER'S THESIS

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- ABSTRACT -

The initial design of a system is an important phase of the Software Life Cycle. This research examines the understandability of software design methods. Two independent groups, students and professionals, were asked to answer questions about system diagrams which were represented using four software design methods. These methods are Higher Order Software (HOS), Jackson, Warnier-Orr and Yourdon-Constantine. Understandability is measured by the speed and accuracy with which the forty-eight subjects answered the questions.

Each subject was tested on all four methods; therefore, four different systems were needed. The systems are as follows: Savings Account Monthly Report System, Student Advisory System, Country Club system, and a Project Manager System. The questionnaires consist of ten questions. Each question has three to four multiple choice answers. The ten questions are the same for each system, some of the multiple choice answers vary for the particular design method. Before each subject is tested over a particular method, they are given a brief training session. The training session consists of a design method description, an Othello System example diagram and training questions.

The subjects interject their own assumptions into the diagrams for which they think they know the system or the design method instead of actually reading the diagram. They are able to trace the diagrams but have difficulty understanding the diagrams as a whole system. Yourdon-Constantine did the worst overall. For both test groups, it had the highest mean number wrong. Warnier-Orr had both the highest and the lowest mean number of errors for the professionals while it had the lowest overall mean number of errors for the students. Jackson did the worst on the report type system. HOS did the best overall. It had the lowest mean number wrong for the professionals and the second lowest mean number wrong for the students. The choice of which design method is the best depends on a speed/accuracy tradeoff; the accuracy of a software design should be more important than speed in doing the design. It is the hope that this research may show insights to areas of design understandability that need further investigation.