

MCMASTER PATIENT MANAGEMENT PROBLEMS

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MCMASTER PATIENT MANAGEMENT PROBLEMS
A CLINICAL EVALUATION TOOL

By
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A Project
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Abstract

Patient Management Problems is a paper and pencil self-assessment procedure administered by the American College of Surgeons. The participant is presented with a number of problems, each of which describes a patient with an illness or injury. For each problem, the participant must assume the role of surgeon on duty and make decisions as to what he would do next in order to formulate a diagnosis. Each decision is scored in a prescribed manner. Upon completion of the problem, the participant's score reflects his knowledge and clinical competence.

Dr. C. B. Mueller (Health Sciences, McMaster University) has defined a requirement to investigate the feasibility of evaluating a surgeon's ability to discriminate between critical and noncritical information available from a patient. This investigation will employ an evaluation process similar to the one used in Patient Management Problems but will be computerized and will be scored in terms of completeness and efficiency. This computerized evaluation tool will be referred to as McMaster Patient Management Problems (MPMP).

This project paper will describe the activities surrounding the development of McMaster Patient Management Problems.

Acknowledgements

Many thanks are extended to my supervisor, Dr. G. Keech, for assistance and patience throughout the preparation of this project.

Special thanks to Dr. C. B. Mueller for the opportunity to assist him in his research. His patience, support and guidance, despite an already busy schedule, contributed to the development of the computerized McMaster Patient Management Problems.

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I Introduction

1.0 The Problem Setting

An essential skill that a doctor must develop and foster is the ability to discriminate between critical and non-critical information while diagnosing a patient. The basic process is one of sifting through thousands of facts from the patient's history, physical examination and laboratory tests to extract those relevant to the proper management of the patient's current problem. As illustrated in Figure 1, a series of reductions takes place to leave the doctor with seven to thirteen critical facts.

Since the ability to select the relevant data from a large population of facts is central to the performance of a doctor, there is a well recognized need within the profession to continually develop and improve :

- i) suitable methods for assessing this ability;
- ii) instruments for testing the doctor to ensure acceptable performance levels; and
- iii) methods which contribute to the development of this ability.

2.0 The Project

The project involves the design and implementation of a computer program to simulate the Patient Management Problems (PMPs) for Dr. C. B. Mueller in the Faculty of Health Sciences, McMaster University. The computerized procedure will be used, in the first instance, as a tool to investigate the technique of assessing a doctor's ability to discriminate between critical and non-critical data. In particular, it will allow Dr. Mueller to determine if it is possible to measure this ability and, if so, to measure its development with time as a student progresses through his internship. See Figure 2, which illustrates the progress of a student doctor and the behaviors that evolve throughout his maturation.

The first application of the system will see first year medical students, fourth year medical students, interns and experienced medical personnel work through several problems. The results of this trial run will determine the future direction for the development of MPMP. For example, consideration may be given to extending the MPMP system for use both in testing and training.

The system involves a question and answer technique that is modelled after the manual PMP system. Each problem is presented as a case study with a description of a patient and his problem, followed by more than 150 action items, consisting of the patient's history, physical examination, laboratory tests and results, procedures and intervention and therapy. The individual that is being assessed selects as many of these items as he feels are relevant. When an item is selected the result of performing the action is displayed, giving the individual decision criteria for further selections. Upon completion of the problem, scores are calculated to reflect efficiency and completeness.

In addition to the doctor assessment mode, the MPMP system provides an authoring interface. This interface allows the entry and modification of problem text. The case description and action items can be entered, as well as the results for the items.

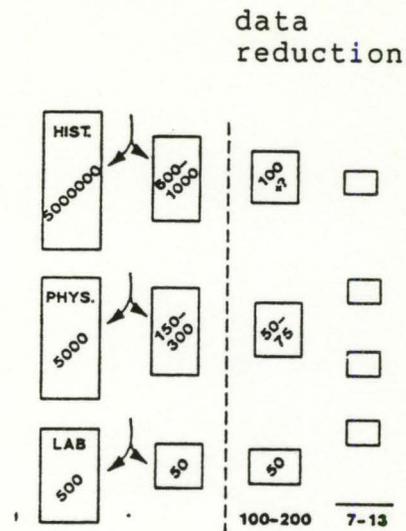


Figure 1 - Illustration of data discrimination

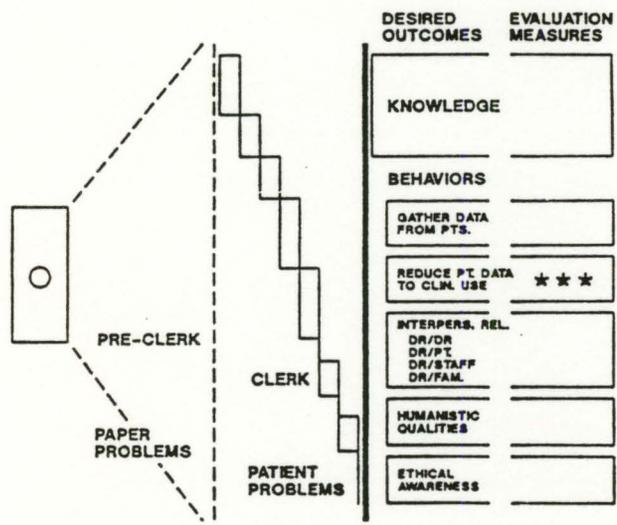


Figure 2 - Steps required for a student to become a doctor

3.0 Glossary of Terms

The following is a list of the terms used throughout this document and the system, with their associated meanings.

->,<- This will correspond to the arrow/cursor keys on the keyboard, located on the numeric keypad, keys 4 and 6.

<--' This symbol will correspond to the ENTER or RETURN key on the keyboard.

case A case is described to be all information and decision criteria related to a particular patient. A case has a name (the patient's name), a **stem** and five (5) **chapters**. Each case has up to twelve possible outcomes.

chapter A chapter is a category of action items. There are five (5) chapters for each case. They are as follows :

1. History

2. Physical Examination
3. Laboratory Tests and Results
4. Procedures and Intervention
5. Therapy

choices Each chapter will display several items from which the user may select any number of choices.

cursor The cursor is the square or underscore that indicates where the next keypush verification will be seen.

item Each chapter will display a set of action items on one or more pages. These items will be from the particular category that the chapter represents. For example, items that appear in chapter 3 will be specific laboratory tests coupled with their respective results. When an item is chosen, the patient's results will be presented.

menu The list of all items on a particular page in any chapter, when displayed to the user, constitutes a menu.

MPMP MPMP represents the acronym that will be used to describe this system - McMaster Patient Management Problems.

outcome The outcome of the case is the final diagnosis as determined by the system administrator when authoring the case. Each case has up to twelve possible outcomes.

page A page is a list of items in a particular chapter for a patient. Each chapter has one or more pages from which to make selections.

result The result is the information or the action that is displayed upon making a selection of an item. The result corresponds to the item that was selected and is displayed to the right of that item on the menu.

review Each user will be given the opportunity to review the selections made so far in the session. Both the item and the response will be presented.

score Each user of the system will be presented with a score. The score will be based on both

completeness and efficiency. Scoring is described in more detail in the section on Functional Requirements.

session A session corresponds to the time spent with the computer by the user, at one sitting.

stem The stem for a case is an initial description of the patient's current status.

system administrator

This is the person who will be responsible for the maintenance of the data comprising the cases.

user The user refers to the student or clinician that is using the system for self assessment.

4.0 Objectives

Through consultation with Dr. Mueller, the following objectives were followed throughout the software development :

- i) Software development occurred using the method of successive versions.

"... is an extension of prototyping in which an initial product skeleton is refined into increasing levels of capability. In this approach, each successive version of the product is a functioning system capable of performing useful work."
(Fairley, 1985)

Each version was presented to Dr. Mueller for his comments and suggestions.

- ii) The display of the result for a selected action item must be within 1 second.

- iii) Each menu selection entry made by the user must be a single keystroke. The ENTER key was not needed to terminate user entry.

- iv) Data integrity. Each entry made was validated and

an informative error message is generated if an error is made.

- v) Robustness. The system acts in a predictable way in the event of incorrect user entry.

- vi) A clear and simple user interface was presented. This was the area deemed most important to the success or failure of the system. See further information in the User Interface section of the Functional Requirements.

5.0 Approach

Traditionally, systems were developed using a linear approach called the Phased Life Cycle Model. This model divides the development cycle into a series of well-defined activities, each resulting in well-defined products. These activities are analysis, design, implementation, system testing and maintenance. (Fairley, 2.3.1)

Both the potential evolution of the use of this software product (research/testing/education), and the considerable experience of Dr. Mueller in this area (with well-defined ideas regarding the user interface) ruled out this traditional method. Clearly the progression from research tool to testing instrument to educational aid will require a number of product iterations. Therefore, the approach that will be taken will be one of successive versions.

Specific reasons for selecting this approach are as follows:

- i) Problem areas were detected at a time when they could be easily modified.
- ii) Continual involvement by Dr. Mueller allowed him to monitor progress as it occurred.
- iii) Research by Baroudi, Olson and Ives indicates that increased user involvement will lead to wider acceptance of the system by the user.

"The expectation that user involvement will increase system usage and user information satisfaction is consistent with the theories of participative decision making and planned organization change...Involvement is seen as a necessary condition for decreasing resistance and increasing acceptance of planned change." (Baroudi, Olson and Ives, 1986)

Therefore, Dr. Mueller participated in all aspects of the development of the MPMP system. Dr. Mueller was able share in the feeling of ownership of and pride in the system after having been involved.

- iv) Iterations placed more emphasis on user requests and changes. This method made it easier to incorporate additional requests that Dr. Mueller had, and also made it possible to make changes in the basic design before it was too complicated to do so.

The development process, then, was undertaken as follows :

- i) System definition and project plan documents were generated by the developer. The developer in this instance is the author of this paper.
- ii) Software requirements were defined and documented. They were formally agreed upon by the client.
- iii) A preliminary design document was presented to and approved by the client. This document contained such items as the expected screen layouts and user interface descriptions, as well as system flow diagrams and module dependency charts.
- iv) Coding and testing began in a top-down fashion as described in the preliminary design document. Regular presentations were made to the client in order that his comments could be incorporated into the system on an ongoing basis.
- v) The system was field tested by several individuals selected jointly by the client and the developer. Feedback was obtained from a questionnaire which is included in Appendix II.
- vi) Modifications arising from the field testing were evaluated and implemented.
- vii) The authoring interface was constructed.

II Requirements Specifications

1.0 Overview

The McMaster Patient Management Problems is a system that provides a tool for evaluating a doctor's reasoning power. It tests his ability to selectively "narrow in" on items critical to the successful diagnosis of a patient. Doctors are presented with a description of the case followed by no more than 150 possible action items, from which they must make selections. He is then scored in terms of completeness and efficiency. For this system, completeness is defined to be when the doctor selects the critical items after a thorough investigation of other alternatives. Efficiency is defined to be when the doctor quickly and effectively identifies the critical items. For more information on scoring, see description of scoring in Functional Requirements section.

The system also provides a means for authoring additional cases and maintaining those currently in the system. It allows modifications to existing cases, both in text and in scoring.

This section describes the functional requirements of the McMaster Patient Management Problems system. It contains a description of the functional requirements, the user interface, exception handling, foreseeable modifications and enhancements and acceptance criteria.

2.0 Functional Requirements

The functional requirements which defined the basis for the design and implementation of the MPMP system are described in detail below. The areas that will be discussed include hardware and software requirements, authoring, aesthetic requirements, scoring and user identification.

1. The MPMP system will operate on an IBM-PC or PC clone. It will be a floppy disk based system that will perform consistently on either a colour or monochrome display monitor. The MPMP system will not require a large amount of memory.

This is a requirement so that the client can conduct testing in an environment that does not require sophisticated hardware. This environment may even be one in which the doctor doing the test is in his own home or office.

2. The MPMP system will automatically begin operation upon booting the computer with the floppy disk inserted in disk drive A.

3. The user will be initially presented with a welcome screen that allows him to elect to see either a long or short set of instructions.
4. After viewing instructions, the user will have the option to see a description of what the scores mean.
5. Once into the case material, each screen shall clearly display the chapter number, chapter name and page number.
6. Every user action will be accomplished by a single keypush. This was a requirement defined by the client, as he had seen several other software products in which the method of entry was not consistent. For example, in once instance the user would enter his action choice followed by the enter key while in another he would only enter his action choice.
7. Users will always be given instructions regarding the valid input.
8. Each user input will be tested for validity. If the entry is not valid, the user will be informed of the error both through an explanation and an audible beep and he will be prompted for another input.

9. All available action options will be displayed along line 23 of the screen.
10. The item choices made by the user on each page of each chapter will be easily distinguished from those items not yet selected by the presence of the result of that item.
11. Both upper and lower case letters will be used and will be accepted as input from the user.
12. The user will be able to move easily between pages in the current chapter.
13. The user will be able to move easily between chapters 1 through 4.
14. Once the user elects to make therapeutic choices (chapter 5), he cannot move back to chapters 1 through 4. This is a requirement stipulated by the client in order to limit the opportunity of making a therapeutic decision. This forces the user to thoroughly think through all other action items and be sure of his conclusion prior to initiating therapeutic action items.
15. The user will be provided with a Review capability in which he can review all of the items previously chosen.
16. Available options will always be displayed along the second to bottom line of the menu.

17. Error messages will always be displayed along the bottom line of the menu.
18. When the user selects chapter 5 he will be asked whether or not he wishes to continue, in view of the fact that he cannot go back to previous chapters.
19. Once the user is in chapter 5, the only options are to select items, review previously selected options or, terminate.
20. The scoring will be calculated as follows :

The scoring in this system is to reflect completeness and efficiency.

Each item will be classified as a critical item (C), and auxiliary item that supports a critical item (A), a nonessential item (N) or a therapeutic item (T).

The user's scores will be calculated based on the selections made by him through the session.

Calculations will be as follows, where
Cu is the # of critical items chosen by the
user

Au is the # of auxiliary items chosen by the user

Tu is the # of therapeutic items chosen by the user

Nu is the # of nonessential items chosen by the user

Ca is the # of critical items defined by the author of the case

Aa is the # of auxiliary items defined by the author of the case

Ta is the # of therapeutic items defined by the author of the case.

$$\text{The completeness index} = \frac{\text{Cu} + \text{Au} + \text{Tu}}{\text{Ca} + \text{Aa} + \text{Ta}} \times 100$$

$$\text{The efficiency index} = \frac{\text{Cu} + \text{Au} + \text{Tu}}{\text{Cu} + \text{Au} + \text{Tu} + \text{Nu}} \times 100$$

Users' scores will be stored for future reference by the system administrator.

21. There will be a computerized mechanism of uniquely identifying the user. Upon starting the system, the user will be prompted to enter his unique identification code. This code will be assigned to him by the system administrator.

22. The particular outcome of the case will be randomly selected for the user at each invocation of the MPMP system.
23. A separate set of programs will be written to provide the system administrator with the facility to create additional cases of modify existing ones.

The administrator will have a set of computerized procedures that will allow him to add, modify and delete cases from the system. They will allow him to enter information partially, that is to say, he will not be required to add all case information at one time. This is a requirement, as for each case there is a tremendous amount of information. Each case has one stem (usually one screen full of general information), and approximately 150 items, each with one result for each outcome of the case. A printing capability is also required to allow the administrator to make a hardcopy of case information.

The authoring system will be totally separate system, not residing on the MPMP system floppy. This is to aid in maintaining integrity of

the system. For instance, a user will not be able to accidentally modify text in the case.

3.0 User Interface

This section describes the effort that went into designing the user interface and concludes with a walk-through of a typical session on the system.

A considerable amount of time was spent by the client and the author of this paper in designing the user interface to MPMP. We decided that the technique of menu selection should be the approach that we would take. Menu selection is defined to be

"The users read a list of items, select the one most appropriate to their task, apply the syntax to indicate their decision, confirm the choice, initiate the action, and observe the effect."
(Schneiderman, 1987)

Menu selection was decided upon since the priority of the users was intended to be one of participating in a test and not fighting with a complicated computer test facility. In an informal survey of other such software attempts, menu selection was the simplest, most popular user interface.

The criteria that was used in defining the appearance and content of the menus was as follows.

i) Consistency

All chapters of each case were displayed in the same manner, and terminology was carefully selected such that it would be familiar to the doctors who would ultimately be using the system. The action of using a single key stroke to select an item was kept consistent throughout the system.

ii) Informative feedback

When a user made an error, it was important that the error reflected the mistake that was made. For example, if there were items 'a' through 'g' on a menu, and a user pressed 'k', the error message he would receive is "Invalid key press. Please try again." This message is far more meaningful than "ERROR" or "SYNTAX ERROR".

iii) No cluttered menus

The number of possible menu selections was kept to seven.

"George Miller's classic 1956 paper, "The magical number seven - plus or minus two," identified the limited capacities people have for absorbing information (Miller, 1956)." (Schneiderman, 1987)

This made the menus less cluttered and not overwhelming for the user.

iv) Like reading a book

The system was constructed in such a way that it resembled the actions of turning the pages of a book. Each case had several chapters. The chapters were accessed via chapter number. Each chapter had one or more pages. These pages were accessed using the left and right arrow keys. The user was given the ability to move easily between chapters.

v) Speed

An attempt was made at keeping the response time to less than two seconds per action.

"...the frequently mentioned two second limit (Miller, 1968) seems appropriate for most tasks." (Schneiderman, 1987)

vi) Simple

The overall goal of the user interface was that it would be simple for the user. This goal was achieved through the use of the criteria outlined above.

A typical session of MPMP goes as follows.

When the user is ready to begin he inserts his floppy into disk A and turns the computer on. He is presented with a screen that welcomes him to the system and prompts for his unique id code.

```

Welcome to the
COMPUTERIZED
PATIENT MANAGEMENT PROBLEMS
C. B. Mueller
N. Elop

copyright, McMaster University, 1987

Please enter the number on your card and press the <--' key :
```

Here, the user entered a '9' and followed it by pressing the '<--'' key. This is the only place in the system where the '<--' key is required to terminate entry, and explicit instructions are given. The user number is validated.

```

Welcome to the
COMPUTERIZED
PATIENT MANAGEMENT PROBLEMS
C. B. Mueller
N. Elop

copyright, McMaster University, 1987

Please enter the number on your card and press the <--' key : 9
Your number is          9
Correct ? (Y/N)
```

When the user is satisfied with his user number, the system then asks him if he would like to see a full or short set of instructions. In this example, the user entered 's' and was presented with the short instructions.

```

Welcome to the
COMPUTERIZED
PATIENT MANAGEMENT PROBLEMS

C. B. Mueller
N. Elop

copyright, McMaster University, 1987

Please enter the number on your card and press the <--' key : 9
Do you wish short or full instructions ? (S/F)

```

Now the user has the option of seeing a description of the scoring mechanism.

```

Patient Management Problems
INSTRUCTIONS

Pressing
Numbers 1 - 5 will get you chapters
History, Physical, Laboratory, Special, Therapy
Letters A - G will select from the current menu

I will redisplay this instruction screen.
R will review everything already selected
S will relist the stem
T will terminate the program and display your score
<-, -> will move between pages in a chapter (keypad 4 & 6)

The symbol <--' corresponds to the Enter or Return key.

All acceptable options will be displayed at the bottom of the
screen.

Do you wish to see description of scoring ? (Y/N)

```

After reading the scoring screen, the user is required to press the '<--' key to continue. Now the stem of the case is presented.

```

Patient Management Problems
Case      : George Basangio           Chapter : The Stem
                                           Page    : 1 of 1

Fifty-six year old male of Sicilian decent, well-dressed, a minor
executive in the transit company has a second floor walk-up apartment.
He has noted increasing shortness of breath while walking up the stairs
during the prior 4-8 months. He had previously been diagnosed as having
arthritis because of pains in his metacarpophalangeal joints, left
ankle and left great toe. A social drinker, he confesses to two
martinis each day before dinner. His work load has been increasing
lately. He is married, has three children, 25-28-29, who are no
longer in school or at home.

Please press 1,2,3,4,5, 1,s or t

```

After reading the stem information, the user can elect to see any of the chapters, the instructions, the stem again or terminate. In this example, the user entered '1'.

```

HISTORICAL ITEMS
Case      : George Basangio           Chapter : 1
                                           Page    : 1 of 3

a) abdominal cramps.....
b) change in bowel habits.....
c) character of stool.....
d) caliber of stool.....
e) color of stool.....
f) weakness.....
g) sore tongue.....

Please press a,b,c,d,e,f,g, 1,2,3,4,5, 1,r,s,t, <- or ->

```

On this screen, the user selected the item 'f', and the item 'd' followed by the item 'j'. There is no item 'j', so the user is informed of the error.

```

                                H I S T O R I C A L   I T E M S
Case      : George Basangio          Chapter : 1
          --                          Page    : 1 of 3

a) abdominal cramps.....
b) change in bowel habits.....
c) character of stool.....
d) caliber of stool.....          normal - no change
e) color of stool.....
f) weakness.....                  yes - easily exhausted
g) sore tongue.....

Please press a,b,c,d,e,f,g, 1,2,3,4,5, 1,r,s,t, <- or ->
Invalid key press. Please try again

```

Now the user goes to page 2 of chapter 1 by pressing the right arrow key.

```

                                H I S T O R I C A L   I T E M S
Case      : George Basangio          Chapter : 1
          --                          Page    : 2 of 3

a) numbness and tingling of feet..
b) anorexia.....
c) weight loss.....
d) food preference.....
e) medications.....
f) others in family affected.....
g) color of urine.....

Please press a,b,c,d,e,f,g, 1,2,3,4,5, 1,r,s,t, <- or ->

```

He then selects items 'c', 'd' and 'e'.

```

                                H I S T O R I C A L   I T E M S
Case      : George Bazangio          Chapter : 1
                                           Page   : 2 of 3

a) numbness and tingling of feet..
b) anorexia.....
c) weight loss..... none
d) food preference..... likes Italian/Mediterranean food
                           including Fava beans
e) medications..... Probenecid - Enterophen
f) others in family affected.....
g) color of urine.....

Please press a,b,c,d,e,f,g, 1,2,3,4,5, 1,r,s,t, <- or -> e

```

The user uses the right arrow key once more to go to page 3 of chapter 1. He selects all items on this menu and then presses the right arrow key again. Since he is already at the last page of the chapter, he receives an appropriate error message.

```

                                H I S T O R I C A L   I T E M S
Case      : George Bazangio          Chapter : 1
                                           Page   : 3 of 3

a) discomfort after meals..... none
b) heart burn..... not noted
c) waterbrash..... not described
d) belching..... none
e) awake at night with abdominal.. no
   discomfort

Please press a,b,c,d,e,f,g, 1,2,3,4,5, 1,r,s,t, <- or ->
Already at the last page of this chapter

```

Then the user selected to go to chapter 3 by pressing the '3'. He selected items 'a', 'b', 'c', and then pressed the left arrow key to go back a page. Since he is already on the first page of the chapter, he receives the appropriate error message.

LABORATORY TESTS			
Case	: George Basangio	Chapter	: 3
	←	Page	: 1 of 4
		patient's results	normal
		-----	-----
a) red blood cells	Hb.....	100 Gm/L	140-180
	Hct.....	0.32	2.39-2.49
b) red blood cells	count.....	$3.5 \times 10^{12} / L$	$4.2-5.6$
	MCV.....	88 f/L	76-100
c) red blood cells	MCHb.....	31 pg	27-33
	MCHbC.....	35 Gm/L	330-370
d) reticulocytes.....			
e) platelets.....			
f) white blood cell count.....			
g) differential.....			
Please press a,b,c,d,e,f,g, 1,2,3,4,5, 1,r,s,t, <- or ->			
Already at first page of chapter			

Now the user selected '5' in order to go to chapter 5. The system confirms that the user does indeed want to go to chapter 5. The user pressed 'y'.

Once in chapter 5, the user pressed '4'. He was informed that previous chapters cannot be accessed once in chapter 5.

P R O C E D U R E S and I N T E R V E N T I O N

Case : George Basangio

Chapter : 4

Page : 1 of 3

- a) ECG.....
- b) air contrast ba enema..... normal colon - no diverticulae
no obstructing lesions
- c) digital exam of rectum.....
- d) anoscopy.....
- e) flexible sigmoidoscopy.....
- f) colonoscopy..... normal mucosa to cecum -no bleeding
points identified
- g) cystoscopy.....

Please press a,b,c,d,e,f,g, 1,2,3,4,5, 1,r,s,t, <- or -> 5
Once in chapter 5, there is no turning back. Are you sure? (y/n)

D R U G S and/or O P E R A T I O N S

Case : George Basangio

Chapter : 5

Page : 1 of 3

- a) op total proctocolectomy.....
- b) op resect right colon.....
- c) op resect sigmoid colon..... not indicated
- d) op resect distal stomach.....
- e) op pyloroplasty and vagotomy...
- f) give Vit B12 cyanobalamin..... not indicated
- g) disc. Probenecid..... done

Please press a,b,c,d,e,f,g, 1,r,t, <- or -> 4
You cannot redo previous chapters once in chapter 5

The user decided to review the item choices that he had made during the session. He does so by pressing 'r'.

```

                                R E V I E W

Items already chosen :          Results :
-----
caliber of stool.....         normal - no change
weakness.....                 yes - easily exhausted
weight loss.....              none
food preference.....           likes Italian/Mediterranean food
                                including Fava beans
medications.....               Probenecid - Enterophen
discomfort after meals.....     none
heart burn.....                not noted
waterbrash.....                not described

Press <--' to continue

```

The user selected items 'c', 'f' and 'g' and then decided to terminate by pressing 't'. The system confirms the decision. The user pressed 'y'.

```

                                D R U G S  a n d / o r  O P E R A T I O N S

Case      : George Basangio          Chapter : 5
                                Page      : 1 of 3

a) op total proctocolectomy.....
b) op resect right colon.....
c) op resect sigmoid colon.....     not indicated
d) op resect distal stomach.....
e) op pyloroplasty and vagotomy...
f) give Vit B12 cyanobalamin.....     not indicated
g) disc. Probenecid.....              done

Please press a,b,c,d,e,f,g, i,r,t, <- or -> t
Your score will be calculated and the session will end.  OK ? (Y/N)

```

The user is displayed his score.

```

      P a t i e n t   M a n a g e m e n t   P r o b l e m s
                S C O R E

You have achieved the following :

      C o m p l e t e n e s s   I n d e x   :   28.57
      E f f i c i e n c y   I n d e x   :   44.44
      C a s e   O u t c o m e   :   101

This score is known only to you and the administrator of this system.
It will be used in generating statistics and will in no way be used
as a basis for judgement, either for or against you.

Please record this information on your card.

Press the <--' key ...

```

The user presses the <--' key to continue, then presses it again to exit from the system.

```

      P a t i e n t   M a n a g e m e n t   P r o b l e m s

Thankyou for participating in this study.

If you would like further information regarding your score,
please contact :

      D r .   C .   B .   M u e l l e r
      D e p a r t m e n t   o f   S u r g e r y
      F a c u l t y   o f   H e a l t h   S c i e n c e s
      M c M a s t e r   U n i v e r s i t y ,   H a m i l t o n ,   O n t a r i o
      T e l e p h o n e   -   ( 4 1 6 ) 5 2 1 - 2 1 0 0   e x t .   5 2 3 0

      H A V E   A   N I C E   D A Y   ! !

Once at the A> prompt, to reactivate PMP's enter
A> pmp      (followed by the <--' key)

Press <--' to exit

```

4.0 Exception Handling

The user entry errors that this system is capable of handling are as follows :

- i) The user makes a selection that is not one of the available options.

Result

The message "Invalid key press. Please try again" is displayed along the bottom line. An audible tone is also heard. He is then able to make another selection.

- ii) The user selects an item that is not on the menu. For example, on the last page of a chapter, there may only be items a through to d. The user could select item 'f'.

Result

Because 'f' is a valid selection on item menus, but there happens to be no 'f' on the current page, the message "There is no item 'f' on this menu" displays. An audible tone is also heard. The user is then able to make another selection.

- iii) The user is in chapter 5 and tries to go back to another chapter.

Result

The message "You cannot redo previous chapters once in chapter 5" is displayed. An audible tone is heard and the user is left in chapter 5. He can make another selection.

- iv) The user is on the last page of the current chapter. He may try to go to the next page.

Result

The message "Already at last page of this chapter" is displayed and an audible tone is heard. The user can then make another selection.

- v) The user is on the first page of the current chapter. He may try to go to the previous page.

Result

The message "Already at first page of this chapter" is displayed and an audible tone is heard. The user can then make another selection.

5.0 Foreseeable Modifications and Enhancements

The following section describes two areas where modifications and enhancements would extend the areas of application of the system.

- i) The user is not ever informed of the correct answer. If this were done, the examination tool would become an educational tool. Various aspects could be introduced at this point. The user could be questioned about selections and more feedback could be presented to the user.

- ii) The system could be easily modified to totally computerize the current SESAP (Surgical Education and Self-Assessment Program) evaluation system. The main difference between SESAP and MPMP is the calculation of the score. In the SESAP system, each item is assigned a numeric value. The score is calculated as a tally of the numbers representing the items chosen.

6.0 Acceptance

During the development of the MPMP system, several acceptance activities occurred. They are listed below.

- i) The preliminary requirements document was accepted by the client. This acceptance signified that the client was confident that the author of this paper understood the requirements of the system.
- ii) The fully functional system was accepted by the client. The acceptance criteria was the list of requirements that appears in section 2.0, Functional Requirements. See appendix II for the completed criteria list and signatures.
- iii) Once the system had been field tested and comments had been compiled, several areas of the system were modified.
- iv) The authoring system was also accepted based on meeting requirements specified in section 2.0, Functional Requirements.

III Design

1.0 Strategy

The design of the MPMP system underwent the following steps:

i) Functional decomposition

In this stage, the system was broken down into distinct functional units. See figure 3 for the MPMP system structure chart.

ii) Modularization

At this stage, the functional units were broken down further into modules.

Modules, then, could be translated directly into programming code.

The reason that this particular design strategy was adopted is that the nature of the project being what it is, that this is the first in a series of products, suggests that **change** will be imminent.

"...that the easiest systems to change are those built up from manageably small modules, each of which are as far as possible independent of one another, so that they can be taken out of the system, changed, and put back in without affecting the rest of the system." (Gane and Sarson, 1979)

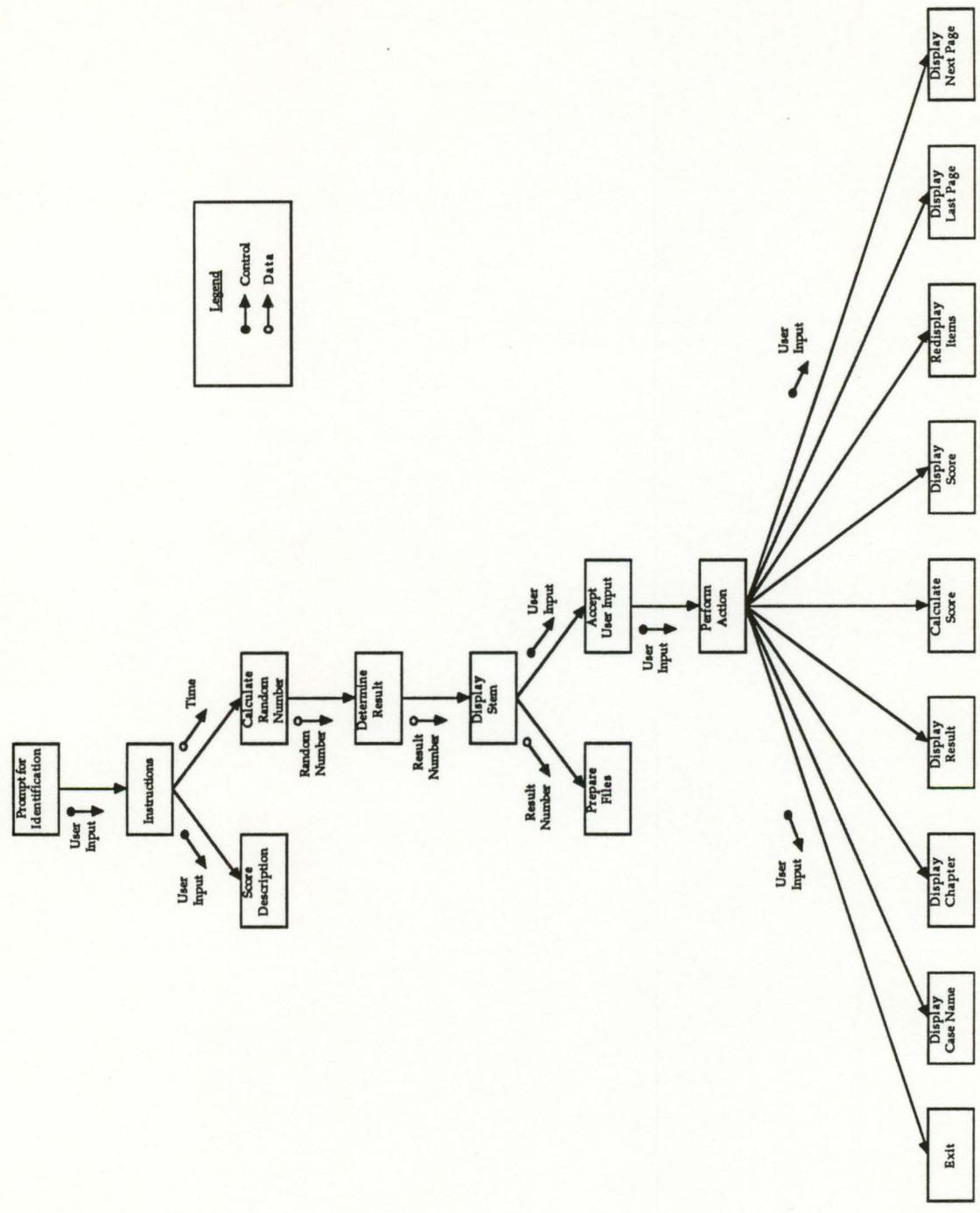


Figure 3 - MPMP System Structure Chart

Each physical module, then, was documented. The information required for each module was name, calling module, effects and modifications. See Appendix IV for all procedure specifications.

IV Users' Guides

1.0 MPMP User Guide

The MPMP Users' Manual consisted of a single card with instructions similar to the short set of on-line instructions. The intention of this system was to be as user friendly and simple to use that there would be no requirement for a comprehensive Users Manual.

An illustration of the Quick Reference card is presented in Figure 4.

INSTRUCTIONS

Numbers

- 1 - 5 gets chapters:
 - History, Physical, Lab, Special, Therapy
 - Each Chapter has 2 or more pages
- ←- → moves between pages in a chapter
 - These are found as 4 and 6 in the numeric keypad

Letters

- a - g selects from the menu on the screen
- i displays the instruction screen
- r reviews everything already selected
- s relists the stem (the case)
- t terminates the program and displays your score

The symbol ←-↵ corresponds to the ENTER or RETURN key

All acceptable options are displayed on every screen

Figure 4 - MPMP Users' Quick Reference Card

2.0 MPMP Authoring User Guide

The section to follow contains the User's Manual for the Authoring subsection.

Note : As implemented, the authoring system used P-Edit, but any editor (or Word Processor capable of creating an ASCII file) could be used.

PATIENT MANAGEMENT PROBLEMS

User's Guide

for the Authoring Subsystem

Introduction

The Authoring subsystem of McMaster Patient Management Problems consists of a mechanism whereby the system administrator can create, modify and delete new MPMP problems. It also includes a mechanism to create new MPMP diskettes.

It resides on a single floppy diskette, separate from the MPMP diskette. This ensures that the integrity of the data on the active MPMP floppy will be maintained. It also allows the administrator to partially complete entering data and to make modifications prior to activating the new problem.

This manual provides a description of each menu selection and how the system is to be used.

Starting up the system

To start up the authoring system, follow the following steps :

1. Place authoring diskette into disk drive A.
2. Power on the computer.

The system will automatically start up and will display the welcome menu for authoring.

You will be prompted to

"Press <--' to continue ..." .

The <--' symbol corresponds to the key with the Enter or Return key on the main keyboard.

The Main Menu

The main menu looks like this :

```

                A u t h o r i n g
    1. Create new case
    2. Enter results
    3. Modify existing case
    4. Delete case
    5. Copy case to MPMP disk
    6. Exit
Enter 1,2,3,4,5 or 6 : _

```

You are prompted to enter a number between 1 and 6, corresponding to the action that you desire. The <--' key is NOT required after the numeric entry.

Option #1 - Create New Case

This option must be selected prior to any other. The new case must be created prior to trying to enter results or modifying anything.

You will be prompted to enter the patient's name. You should enter the patient's full name, with the first name not exceeding 8 characters.

You will then be prompted to enter the stem information. Each line must be terminated with a '<--'. To terminate entry, press the '<--' key at the beginning of a line.

Once the stem information has been entered, you will be prompted to enter the item text for all 5 chapters. Each item line should not exceed 35 characters - a ruler is provided at the top of each screen. Each item spans two lines and each line must be terminated by pressing the '<--' key. If the item only has text for one line, the '<--' key must be pressed at the beginning of line two, thereby leaving a blank line.

Option #2 - Enter Results

This option can be selected at any time following the creation of the case.

As in option #1, you are prompted for the patient's name. You are also prompted for the result file number. For example, Sally Smith could have 4 possible result files. Therefore, the filenames would be sally1, sally2, sally3 and sally4.

Providing that the case file has been already created, you will be prompted to enter the results for each item. The item will be displayed, as it will be shown on the MPMP screens. The result should be entered on this screen in the same way that it should be displayed in the MPMP system. The results span two lines and each line must be terminated by pressing the '<--' key.

After entering the results for each item of each chapter, the data is automatically saved on disk.

Option #3 - Modify Existing Case

This option can be selected at any time following the creation of the case.

As in option #1, you will be prompted for the patient's name. You are then asked if you wish to edit the stem/item information or the result information. If result

information is to be modified, you are prompted to enter the result file number as well.

Providing that the file is present on the floppy in disk A, the file is edited using the editor P-Edit. You will be automatically put into the editor with the appropriate file information displayed on the screen. The file format must be maintained.

To exit the editor, press the F7 key and respond to the P-Edit prompts.

Option #4 - Delete Case

This option can be selected at any time following the creation of the case. It will delete all stem/item and result files.

As in option #1, you will be prompted for the patient's name.

Option #5 - Copy case to MPMP disk

This option should be selected when all information regarding a case and its result files is deemed correct by the system administrator. It will copy all files to the MPMP floppy that is placed in disk B.

As in option #1, you will be prompted for the patient's name.

Option #6 - Exit

Selection of this option exits the system.

Notes -

1. The first name of the patient must not exceed 8 characters.
2. The authoring floppy must be in disk A.
3. Each case should be fully completed and copied before the next is begun. The file case.dat on the floppy contains the name of the case, and will be overwritten if a second case is created while the first case is not yet completed.
4. Each of the stem/item and result files can be printed using the standard DOS print utility. Boot the system normally with DOS and specifically print the files.

V Discussion and Conclusions

This section contains the perceptions of the author following the implementation of the MPMP system. It discusses the topics of user involvement and development through successive iterations. User involvement will be discussed in the broad sense, with references to the user of the MPMP system as being Dr. Mueller.

Over the past several years, the issue of user involvement has been revisited many times. Studies have been done, and those of us in the field deal with it each day. How much should a user be involved in the process of project development? Should he be involved in the design? Should he be involved throughout the programming phase? During this project of implementing the MPMP system, Dr. Mueller was involved in every aspect. Of course, he assisted in compiling the list of requirements. Weekly he was aware of the progress of the system through a demonstration of the partial system. At these demonstrations, he was able to provide comments and input to the aesthetics and functionality. Because of the fact that Dr. Mueller had thought through the requirements so clearly, his input proved to be extremely useful. After

the demonstrations, the comments were incorporated into the system, prior to continuing on the additional functionality. Several things evolved from this process. The overall development time seemed to take longer, as the continual inclusion of changes takes time, however, in the end, the system turned out to be much better suited to his needs. He was able to share in the responsibility of the system, thus sharing the ownership and pride for the system. His satisfaction with the system was a direct reflection of the amount of time he spent involved with the development.

Development by successive iterations is almost implied directly when heavy user involvement is employed. Each time the user defined changes are incorporated back into the system and the user has another opportunity to provide input, iterations of the software are produced. In the proper sense, successive iterations is when additional functionality is added. Each iteration of software did in fact include user input as well as increased functionality.

Given the environment of the MPMP system, the approach that was taken in development proved to be one that worked well for both Dr. Mueller and the author of this paper.

VI Bibliography

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APPENDIX I - Preliminary Schedule

The following represents the preliminary schedule set out for this project. Activities correspond to the tasks defined in the project plan.

Activity	Expected Completion
Define functional requirements	June 15, 1987
Preliminary design	August 15, 1987
Iterated coding, testing and debugging	October 31, 1987
Field testing	November 15, 1987
Modifications	November 30, 1987
Authoring Interface	February 29, 1988

Appendix II - Acceptance Test Plan and Results

The following is a copy of the plan that was followed in accepting the system. The items on the list correspond to the items listed in the functional requirements section.

Acceptance Test Plan

Brief description	Acceptance
1. IBM-PC clone	<u>CSM</u>
2. Auto startup	<u>CSM</u>
3. Turbo Basic	<u>CSM</u>
4. Welcome/Instructions	<u>CSM</u>
5. Scoring description	<u>CSM</u>

- | | | |
|-----|-----------------------------|-----|
| 6. | Chapter number, name & page | " ✓ |
| 7. | Single keypush | " ✓ |
| 8. | Input instructions | ✓ |
| 9. | Input validation | " ✓ |
| 10. | Action options | ✓ |
| 11. | Response | " ✓ |
| 12. | Upper/lower case | " ✓ |
| 13. | Easy page movement | " ✓ |
| 14. | Easy chapter movement | ✓ |
| 15. | Chapter 5 restrictions | " ✓ |
| 16. | Review capability | ✓ |
| 17. | Second bottom line | " ✓ |
| 18. | Bottom line | ✓ |
| 19. | Scoring | " ✓ |
| 20. | Unique id for user | " ✓ |
| 21. | 3-12 possible results | " ✓ |
| 22. | Random selection | " ✓ |
| 23. | <u>Authoring</u> | ✓ |
| 24. | Chapter 5 verification | " ✓ |
| 25. | Chapter 5 selections | ✓ |
| 26. | Result representation | " ✓ |

Date

15 Mar 86

Customer Signature

C. B. Mullen

Appendix III - Questionnaire Results

The following pages are copies of the questionnaire that was returned by individuals that field tested the MPMP system.

Computerized

Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

- WELL Laid OUT, GOOD CURRENT INFO MARKS AS TO LOCATION
- SYMPTOM HIST. SHOULD REFLECT THOSE AVAILABLE, E. IF ~~SEVERAL~~ OPTIONS ONLY, GO TO ~~BE~~, HIST SHOULD END AT E.

Is the system EASY TO USE ?

- ~~CONFUSING~~ - YES, MENUS WELL Laid OUT, INSTANT INFO RETURN IS GOOD
- ALLOWS NORMAL PILOT TYPE ERRORS WITHOUT CENSURING
- FLOWS VERY WELL → I HAVE THE ABILITY TO GO FWD AND BACKWARD
- WHAT IS VALUE OF CASE OUTCOME?

What would you CHANGE ?

- WOULD NOT BE ABLE TO GET OUT OF "THEORY" DESCRIPTION OF RESOURCES ON FIRST PAGE
- ? TOO MANY FUNCTIONS OR CASE DESCRIPTIONS → STATE THAT THESE ARE IN QUICK INTRODUCTIONS
- ✓ - SPREAD OUT OPTIONS AREA

General Comments

- QUITE EASY AND INTERACTIVE TO USE, DELIBERATE ATTEMPTS TO CONFOUND THE SYSTEM WERE THWARTED, THE POINTS MADE ABOVE ARE FINE-TUNING AND MINOR. ABOVE ALL IT WAS FUN. COUNSELLING AS A TX OPTION?

Name Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller,
McMaster University,
Hamilton, Ontario

Computerized

Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

..... hard to turn up brightness on monitor
.....
.....

Is the system EASY TO USE ? Yes, but could be even easier

..... instruction (I) would facilitate learning the meaning of the letters.
..... review (R) if the letters were placed after the words in the
..... re-list stem(s) ← fashion
..... terminate (T)

What would you CHANGE ?

..... terminate might be replaced with quit
..... vague discomfort (or vague)? not
.....
.....

General Comments

..... didn't respond to < or > (Tandy 1000)
..... should be of considerable pedagogic value
..... do you plan to provide feedback about why certain choices
..... are not informative etc. ?

Name Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller,
McMaster University,
Hamilton, Ontario

Computerised
Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

uncluttered, well laid out

Is the system EASY TO USE ?

Yes, very easy

What would you CHANGE ?

General Comments

I'm not a medical student and cannot comment on content of the system. Once the score has been calculated, can the student find out the correct answers & where he or she went wrong?

Name Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller, McMaster University, Hamilton, Ontario

Computerized

Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

Easy to understand

Is the system EASY TO USE ?

Yes, I can find my way around it.

What would you CHANGE ?

Cannot think of anything that needs changing.

General Comments

Name Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller,
McMaster University,
Hamilton, Ontario

Computerized
Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

fine, except that I found the green-on-black colors annoying. Looks like the Turbo Pascal editor.

Is the system EASY TO USE ?

Yes. - And a bit of fun as well, even for a non-medically trained twist like me.

What would you CHANGE ?

? The short menu at the bottom of each screen does not clearly indicate what the numbers and letters stand for. Perhaps a 3-4 line menu.

General Comments

I really would have liked to know what George's problem was. (Especially after having achieved an efficiency rating of 13%!).

Namey..... Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller, McMaster University, Hamilton, Ontario

Computerized

Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

... I find only one problem with the program appearance
... which is related to ① in "change" below
.....
.....

Is the system EASY TO USE ?

... Yes! I'm not at all acquainted with computers
... and was able to understand instructions clearly
... and with little effort. Program didn't load properly
... until 3rd try. This was somewhat disconcerting
.....

What would you CHANGE ?

1. ✓ ① Do not allow sentences/paragraphs to be continued to
... next page - this makes the text disjointed and detracts
... from the overall appearance of the display
.....
2. ② Identify that ← means "return" before it ~~is~~ ^{over}
.....

General Comments

... Very enjoyable, but obviously means for a
... more senior level. I hope you will make these
... available with a variety of screens
.....
.....

Name Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller,
McMaster University,
Hamilton, Ontario

Computerized

Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

Extremely concise

Is the system EASY TO USE ?

Instructions are clear & user friendly. A keyboard card which summarizes key commands and instructions might be of help:

What would you CHANGE ?

If system gave list of critical information after giving score learning would be enhanced.

General Comments

Even a fast to use

Name Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller,
McMaster University,
Hamilton, Ontario

Computerized
Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

Organized, Neat.
Looked very much like turning pages in a book.

Is the system EASY TO USE ?

The page turning instructions on the screen were confusing - see comment on the back
The score was calculated for me, but I don't know what I lost or gained point for.

What would you CHANGE ?

It would be helpful to get back to the full instructions.

General Comments

Hadn't get "< or >" to work at the bottom of chapter 1 page 1 of 3 - got it.
- pag. 2 chptr 2 section - soft "start" flow menu - is that a spelling word?

Name Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller, McMaster University, Hamilton, Ontario

1. the full instructions + explanation
 move between the pages of ^{the program} _(consider it will be fine)
 chapter press <- and ->. The instructions
 on the cover of the disc envelop explain
 to turn the pages use <- - - -> on
 the 4 & 6 of the numeric key pad. This
 works. It would be helpful to have the
 same instructions on the disc full instructions
 on the screen.

Re. Scoring → ① what number is the case outcome out of?
 That is what does it mean? How
 do I interpret the #? Did I do well?

② is there any way to return to
 the chapter + see the "correct"
 answers. To follow along the
 rationale of who designed the program.
 At the end, I wonder ~~what~~
 what did I leave out that
 was important in order ~~to~~
 affect my eff. energy score
 and what did I leave out
 to affect my completeness score?

4

Computerized

Patient Management Problems

As this is a very new system, we would be very interested in obtaining your comments regarding presentation, style, ease of use etc. Please take a moment to write your impressions down.

How does the system LOOK ?

..... The arrows are a bit difficult to distinguish as arrows
and the level of illumination was too low for easy reading
(I couldn't adjust the monitor I was using.)
.....

Is the system EASY TO USE ?

..... Extremely easy! I found the instructions clear
and unambiguous and had no difficulty
..... whatsoever
.....

What would you CHANGE ?

..... I'm not sure what case outcome means or the special
identifying code other than that it's very user friendly.
The only change I might make is to use something more self-explaining
than 'done' to accompany correct choice of therapy
.....

General Comments

.....
.....
.....
.....

Name Phone

Thank you for your time. Please forward this to Dr. C. B. Mueller,
McMaster University,
Hamilton, Ontario

Appendix IV - MPMP System Procedure Specifications

This section will describe each of the modules occurring in the implementation. Each will have the following information :

- i) the procedure (subroutine) name
- ii) other calling routines
- iii) effects
- iv) any modifications made by the procedure
- v) the algorithm (only for complex procedures)

The main driver program will be referred to as 'main'.

Name : welcomescreen

Called by : main

Effect : This procedure clears the screen and displays the welcome, ownership and copyright of the system.

Modifies : nothing

Name : `getuserid`
Called by : `nothing`
Effect : This procedure would prompt the user for his/her unique identification number. This was an original requirement and later removed.
Modifies : `nothing`

Name : `instructions`
Called by : `main`
Effect : This procedure prompts the user to see either short or full instructions. It calculates the time it takes for the user to enter his/her choice and passes this value back to the calling program. This time value acts as the seed to the random number generator that determines which case result will be used. After the user has entered his/her choice, this procedure has the correct information displayed.
Modifies : the random number generator seed

Name : `displayinstns`
Called by : `instructions, performaction,`

Effect : This procedure receives a filename in the call. It proceeds to display the file for the user. After displaying the information to the user, this procedure asks the user if he/she would like to see a description of the scoring mechanism. If the user does want to see scoring, this procedure will have the information displayed.

Modifies : nothing

Name : scoredescription

Called by : displayinstns

Effect : This procedure clears the screen and displays the description of the scoring mechanism.

Modifies : nothing

Name : clearscreen

Called by : displayinstns, displaystem,
displaychapterintro, performaction,
displaychapter

Effect : This procedure receives two integers in the call. It clears the screen in the region between the line numbers represented by the two integers.

Modifies : nothing

Name : **menutop**
Called by : performaction, main
Effect : This procedure displays standard information at
the top of each menu.
Modifies : nothing

Name : **halfmenutop**
Called by : performaction
Effect : This procedure displays half of the standard
information at the top of a menu. It does not
replace the menu title.
Modifies : nothing

Name : **mergefiles**
Called by : preparefiles
Effect : This procedure creates the relative files for the
current case/result. Relative files are created in
order to increase the access time to particular
items and their results.
Modifies : merges case/result data into files
chapter1, chapter2, chapter3, chapter4 and
chapter5

Name : preparefiles

Called by : displaystem

Effect : This procedure uses the case file and the result file. The case file is already open and is positioned at the start of the items in chapter 1. The appropriate result file is opened, also at the start of the items in chapter 1. It creates the files chapter1, chapter2, chapter3, chapter4 and chapter5 one at a time and calls mergefiles to write the merged data from case and result correctly.

Modifies : creates files

Name : displaystem

Called by : performaction, main

Effect : This procedure opens the case file and displays the stem information. While the last page of the stem data is being displayed, it calls preparefiles to make ready the files. If it is called from within the test, a flag is set to not re-prepare the files.

Modifies : nothing

Name : displaycasename
Called by : performaction
Effect : This procedure prints the appropriate name in the
 'Case' field of the chapter menu.
Modifies : nothing

Name : displaychapternum
Called by : performaction, displaychapter
Effect : This procedure prints the appropriate chapter
 number in the 'Chapter #' field of the chapter
 menu.
Modifies : nothing

Name : displaypagenum
Called by : displaystem, displaychapter
Effect : This procedure prints the appropriate page number
 in the 'Page # of #' field of the chapter menu.
Modifies : nothing

Name : displaychapterintro
Called by : displaychapter

Effect : This procedure prints the correct title for each chapter on the menu.

Modifies : nothing

Name : **acceptuserinput**

Called by : main

Effect : This procedure prints the prompt for the user along the second to bottom line of the menu and receives the user input.

Modifies : nothing

Name : **performaction**

Called by : main

Effect : This procedure receives the user input from `acceptuserinput` and validates the input. On receiving a valid entry, `performaction` executes whatever action the user has requested.

Modifies : nothing

Algorithm :

If action requested = i or I then display instructions

If action requested = a,b,c,d,e,f,g or

A,B,C,D,E,F or G then display the result
for the item selected

If action requested = s or S then display
the stem

If action requested = 1,2,3 or 4 then
display page 1 of the chapter requested

If action requested = 5 then ask user for
validation, and then display page 1 of
chapter 5

If action requested = t or T then ask user
for validation and then calculate score,
display score and terminate

If action requested = r or R then display
the review

If action requested = <- then display the
previous page of the current chapter

If action requested = -> then display the
next page of the current chapter

If action requested is anything else, then
call entryerror.

Name : fnMaxpages

Called by : displaychapter

Effects : This function calculates the maximum number of
pages for a particular chapter.

Modifies : nothing

Name : **redisplayitems**

Called by : performaction

Effects : This procedure will redisplay all of the previously chosen items and their results. There will be no designation of chapter, but items will appear in chapter order.

Modifies : nothing

Name : **displayhelp**

Called by : nothing

Effects : This procedure will display a help line along the bottom line of the screen. This was a previous requirement and subsequently removed. The prompt line that the user sees on each menu has all available options now.

Modifies : nothing

Name : **displaychapter**

Called by : performaction, displaylastpage,
displaynextpage

Effects : This procedure will open the appropriate chapter file and display the items and results for the appropriate page.

Modifies : nothing

Name : displaylastpage

Called by : performaction

Effects : This procedure will display the items and results for the page prior to the current page in the current chapter.

Modifies : nothing

Name : displaynextpage

Called by : performaction

Effects : This procedure will display the items and results for the page after the current page in the current chapter.

Modifies : nothing

Name : entryerror

Called by : performaction

Effects : Informs user of an entry error by displaying an error message along the bottom line of the screen and also generates an audible tone.

Modifies : nothing

Name : displayresult

Called by : performaction

Effects : For a given chapter, page and item, this procedure will display the result. It also sets a flag in the chapter file to indicate that the item has been chosen.

Modifies : the chapter file

Name : calculatesscore

Called by : performaction

Effects : This procedure reads through the chapter files and calculates the score.

Modifies : nothing

Name : displayscore

Called by : performaction

Effects : This procedure clears the screen and displays the score information and gives the user some instructions in recording the score info on his/her card.

Modifies : nothing

Name : goodbyescreen

Called by : main

Effects : This procedure thanks the user for participating in the study and informs him/her how to re-execute the program.

Modifies : nothing

Name : calculaterandom

Called by : main

Effects : This procedure uses the time that was measured in instructions and calculates a random number that will correspond to one of the results.

Modifies : nothing

Name : determineresult

Called by : main

Effects : This procedure matches up the random number with

one of the results. It also calculates the binary representation of the result.

Modifies : nothing

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Name : main

Called by :

Effects : This is the main driving procedure of the system.

Modifies : nothing

Name : welcomescreen

Called by : main

Effects : This procedure clears the screen and displays the welcome and ownership of the program.

Modifies : nothing

Name : makeselection

Called by : main

Effects : This procedure displays the main menu to the user and asks for a selection.

Modifies : nothing

Name : performselection

Called by : main

Effects : This procedure acts upon the selection that was made in makeselection.

Modifies : nothing

Name : entryerror

Called by : performselection

Effects : This procedure informs the user of an entry error by displaying an error message along the bottom line of the screen and generates an audible tone.

Modifies : nothing

Name : clearscreen

Called by : createnew, enterresults, modifystem, modifyresults

Effects : This procedure receives two integers in the call. It clears the screen in the region between the line numbers represented by the two integers.

Modifies : nothing

Name : createnew

Called by : performselection

Effects : This procedure creates a new stem and item data file for a new case. It prompts the user to enter

the case name and then the stem and item information.

Modifies : the stem and item data file for that case

Name : enterresults

Called by : performselection

Effects : This procedure prompts the user to enter the case name and the result file number. The user is then prompted to enter result and score data for each item in that case. The stem and item file for that case must be present. If not, the user is notified and is placed back at the main menu.

Modifies : the result file for that case

Name : modifysystem

Called by : modifycase

Effects : This procedure uses the editor P-Edit to display the chosen stem and item information to the user. The user is then able to add to or modify the data.

Modifies : the stem and item information file.

Name : modifycase

Called by : performselection

Effects : This procedure asks the user which case he wants to modify, then asks if he wants to modify the stem

or the result information. Based on this response, modifycase calls the appropriate modifystem or modifyresults procedure.

Modifies : nothing

Name : **modifyresults**

Called by : modifycase

Effects : This procedure uses the editor P-Edit to display the appropriate results file to the user. The user is then able to add to or modify the data.

Modifies : the results file for the chosen case

Name : **deletecase**

Called by : performselection

Effects : This procedure asks the user which case he wishes to delete, and continues to delete it. All stem/item and result files are deleted.

Modifies : Deletes files.

Name : **copycase**

Called by : performselection

Effects : This procedure will prompt the user to enter which case he wants to copy to a pmp disk. It then asks him to put the pmp disk into drive B: and copies the files from the authoring disk to the pmp

disk. This procedure copies the case.dat file as well.

Modifies : nothing

Name : getcaseanddisknames

Called by : createnew, enterresults, modifycase,
deletecase, copycase

Effects : This procedure prompts the user to enter the
desired case name and then prompts for a disk name.

Modifies : nothing