

## Interval Ear Training Program

Floppy disk to disk drive, run program

The screen reads basic instructions  
 • The student ~~takes his vocal~~  
 chooses between easy, medium, hard  
 and expert

easy: one and two intervals

medium: two to four intervals in a row

hard: three to six intervals ~~with ~~definition~~~~

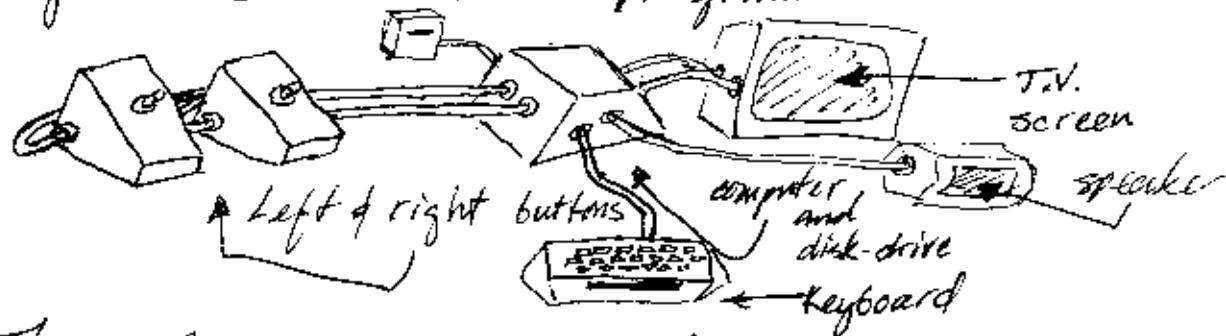
expert: five to ten intervals ~~with ~~definition~~~~

Interview: The student sings intervals requested  
 by the computer into the microphone  
 starting on the note the computer  
 requests through the speaker

The student, after choosing a program,  
 must enter his vocal range.

The computer ~~the screen~~ starts and shows his pitch  
 on the screen and plays it through the  
 speaker and requests an ~~the~~ interval up  
 or down and ~~use~~ the student tries  
 to sing it. There will have to be  
 a small tolerance for pitch variation  
 as well as a minimum time period for  
 the note to be accepted.

## Rhythmic Division Trainer Program



The program is inserted floppy form into the disk drive and loaded in.

The screen reads basic instructions and serves a menu of Easy, medium and hard.

The student makes his choice and enters it.

The computer now gives choices within the level of difficulty, songs or exercises.

The student chooses and enters.

The piece is displayed on the screen a recommended tempo may be changed.

When the student is ready he pushes enter and the computer waits three seconds then counts the first measure with beeps on the speaker.

The student now tries to match the rhythms on the screen; Right hand treble clef, left bass clef. Right hand beeps a higher note than the left.

When the short excerpt has been completed the computer displays beneath the attempted rhythms the actual rhythms played (not too accurately, however, so some kind of tolerance must be employed)

The computer now asks if the student wants to continue on the set, or stop, or repeat the exercise, play the correct rhythms ~~as the way~~ ~~the student just played it~~ or begin a more or less difficult set.

The program should be flexible in tolerance range so that the student won't have to be exact but rather "close enough".

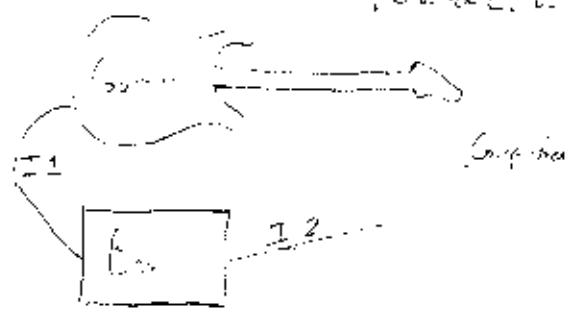
An interesting addition to this program would be to print familiar pieces on the screen and have the student play it by pushing the buttons in correct rhythm.

This program should cover all rhythmic divisions up to 3 against 5, 4 against 5, 5 against 6, 4 against 6, as well as syncopated patterns and standard divisions of the beat.

Q. 1.  $\Rightarrow$  Computer

Dr. B. K. Mittal

- Major Components
- 1) CPU
  - 2) Bus bar
  - 3) Computer
  - 4) Monitor I/O



Q. 2. (a) The computer is a kind of a machine which is used to store, retrieve, process and transmit data. It is a device that can store, retrieve, process and transmit data. It is a device that can store, retrieve, process and transmit data.

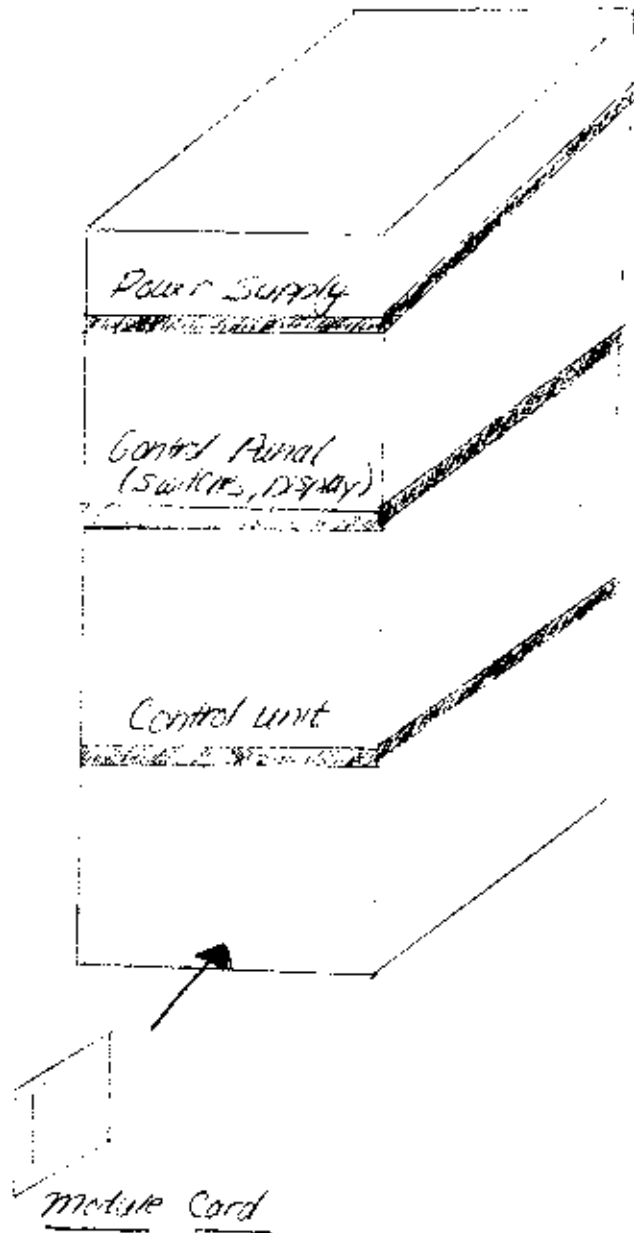
(b) The computer is a kind of a machine which is used to store, retrieve, process and transmit data. It is a device that can store, retrieve, process and transmit data. It is a device that can store, retrieve, process and transmit data.

(c) The computer is a kind of a machine which is used to store, retrieve, process and transmit data. It is a device that can store, retrieve, process and transmit data. It is a device that can store, retrieve, process and transmit data.

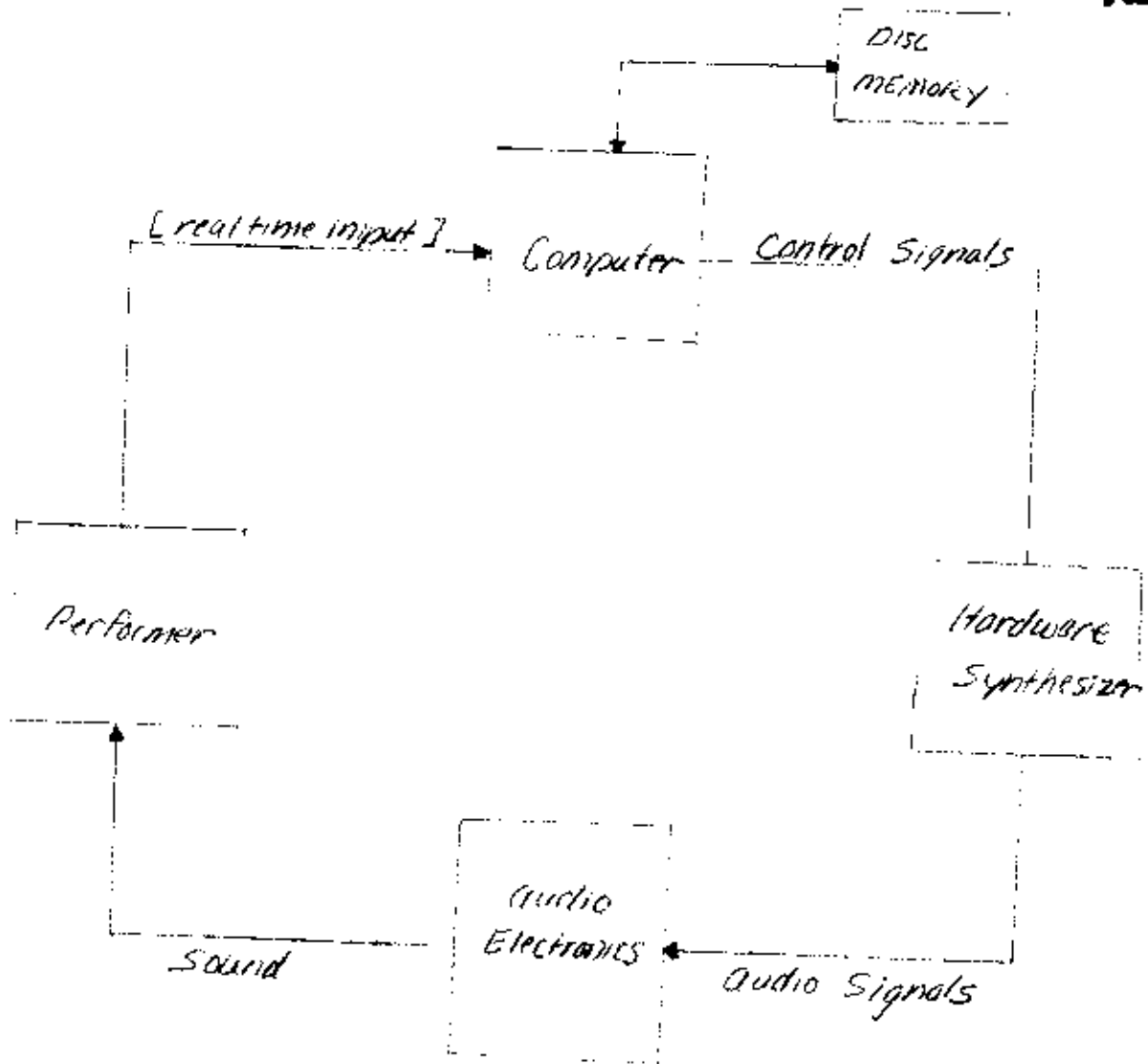
(d) The computer is a kind of a machine which is used to store, retrieve, process and transmit data. It is a device that can store, retrieve, process and transmit data. It is a device that can store, retrieve, process and transmit data.

Note: Optical Research

# Block Diagram of the Physical construction of the hardware synthesizer

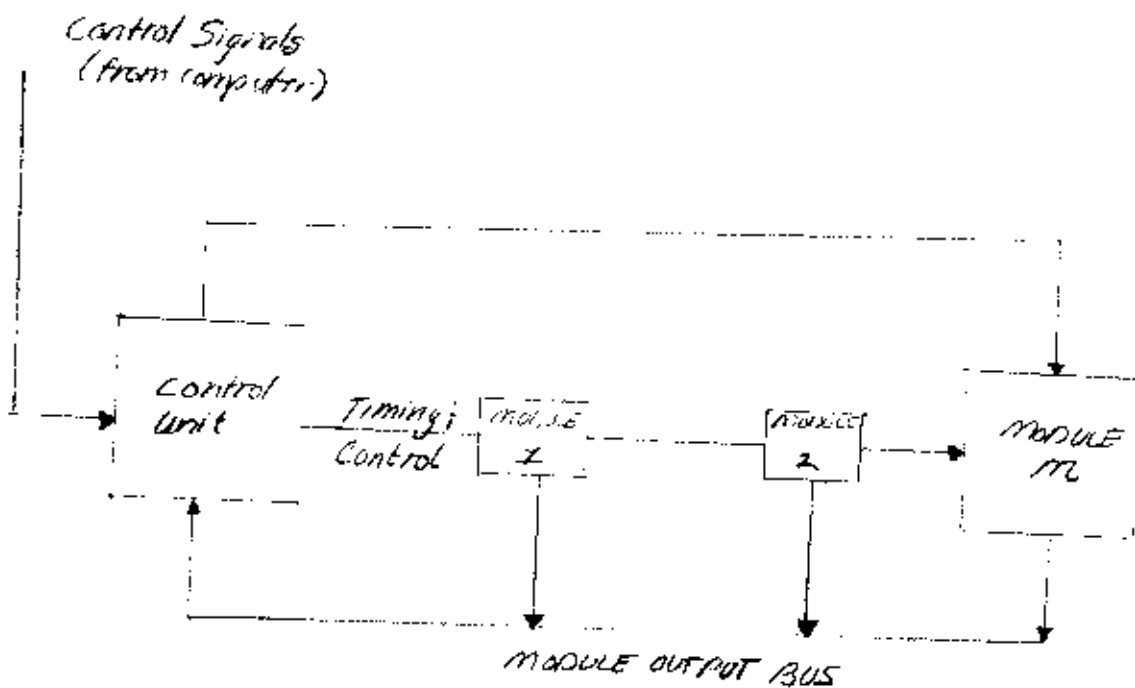


# System Design - Overall Block Diagram of a real interactive computer music facility.



This diagram shows the diagram of the performer generating input info. to the computer by manipulating real time input devices (such as knobs, keyboards, switches etc.) The computer makes a record of the actions of the performer for later reference, combines the inputs currently being generated by the performer with previous inputs, and generates control signals which are fed to the digital hardware sound synthesizer. The synthesizer produces a digital waveform which can be either fed back to the computer or output through a digital-to-analog converter to the audio electronics and loudspeakers (or both) Loudspeakers produce the sound being generated, which can be heard by the performer in real time.

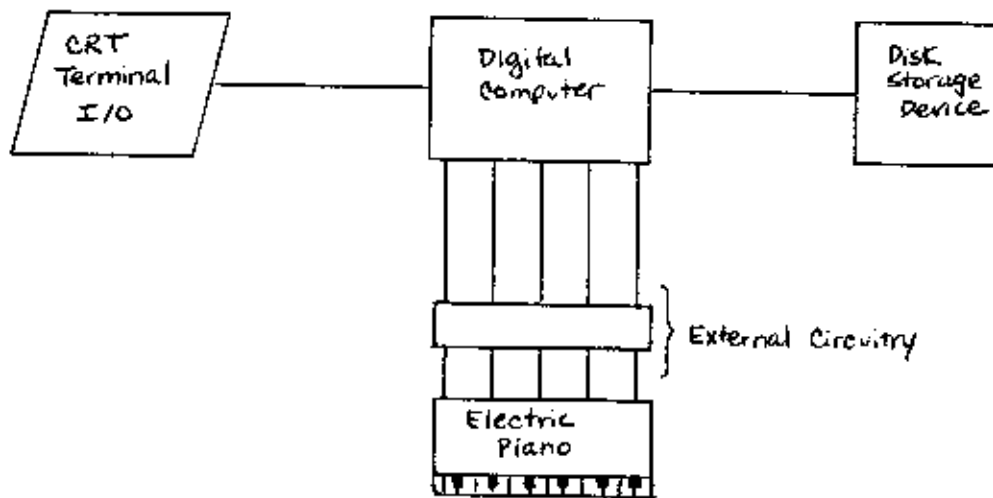
# Synthesizer Control Unit



Block diagram of the real time digital hardware synthesizer. The computer supplies information to the control unit specifying how the signals are to be interchanged, and the exact function of each occurrence of the modules. The computer also supplied real time signals to the synthesizer via one of the module output connections.

General Description

The system that I have designed would enable a composer to encode a piece of music using an easy to understand computer language. The computer would be interfaced with an electric piano to realize the piece. This system would allow the composer to make changes in the piece, repeat sections of the piece, and keep a permanent record of the music, relatively easily.

Hardware Block Diagram

As the diagram shows, the system is implemented using a CRT terminal, a digital computer, a disk storage device, an electric piano and some external circuitry. The circuitry is needed to enable the notes to sound when a logical "1" or positive voltage is applied to the line connecting the computer's output ports to the different notes.

The language (Proposed Symbols)

C, D, E, F, G, A, B - denotes the different notes

1, 2, 4, 8, 16, 32 - to denote the duration of the note (i.e. whole, half, etc.)

↑, ↓ - denotes sharps and flats respectively

2C - numbers immediately preceding the note denote the specific octave (Ex. 2C ⇒ note C, 2<sup>nd</sup> octave)

R - denotes rests (Ex. 1R ⇒ whole rest)

semicolons(;) - separates notes or chords from one another

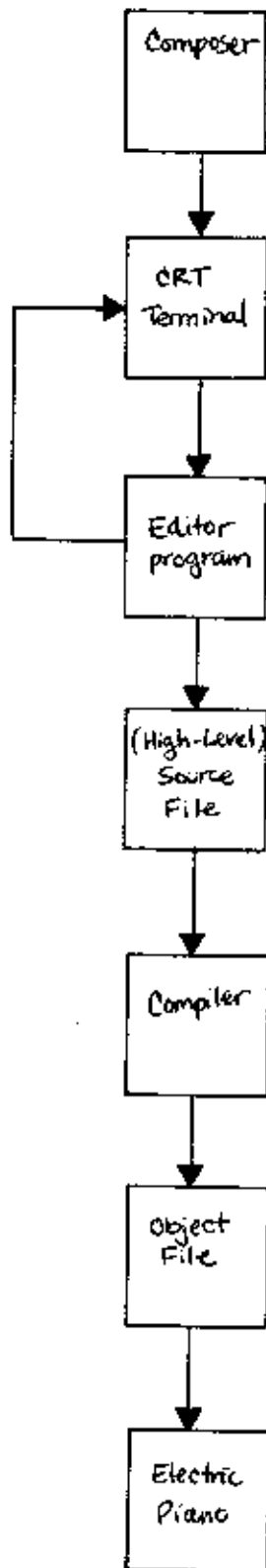
commas(,) - separates duration and notes from each other

BEGIN, END - denotes starting and stopping points of the program

EXAMPLE

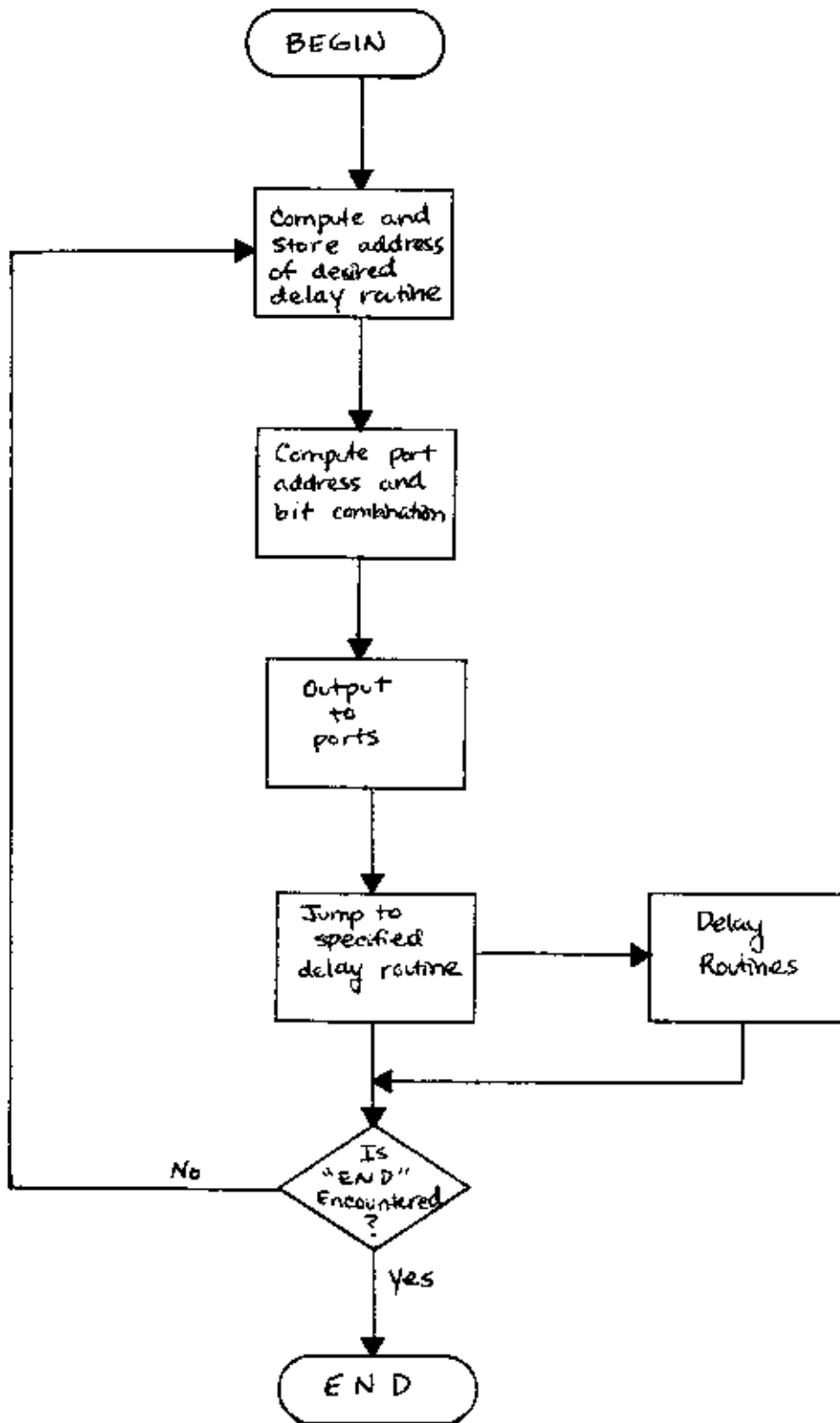
```
BEGIN
4, 3F, 3A, 3C; 4, 4↑A; 2, 4C
.
.
.
.
.
END
```

Using this language format, notes can be played one at a time or they can be played simultaneously to produce chords. This language limits the music to one voice at a time but recording separate voices and mixing them on a tape-recorder can produce multiple voice sounds. This high level language is relatively easy to understand. This makes it easy for the composer but very difficult for the person who must write the compiler for this language.

Software block diagram

For each individual command (separated by semi-colons) the computer must set the proper output port latches in order to enable the desired notes. It must also go through a delay routine which is specified by the note duration. Note that the delay routine for a half note must be two times that of a quarter note. These delay procedures are necessary because the time it takes the computer to execute a single instruction is far less than the ~~time~~ length of time a single note or chord must be sounded regardless of the notes duration. The combination of the octave number and name of the note gives the address of the port and the bit pattern to be output.

BASIC Program Flowchart (Compiler)



COMPUTERISED SYSTEM OF MUSICAL PRODUCTION

Glenn Stiglic

Pure music is the end result of a multiple step procedure which, until only recently, was entirely completed by human hands, which at times is a slow and tedious task.. These steps which transform the spark of inspiration into an actual piece of music are often mechanical in nature, and can be outlined in an occurrence of events :

- (1) Realisation of musical ideas. (Thoughts transformed to a visible, workable score.
- (2) Manipulation of an idea by voice texture, variation, and timbres.
- (3) Manuscript of final composition.
- (4) Performance of composition.

Steps 1-3 are the time consuming mechanics of composing, that make step 4 possible. Step 4 is perhaps the most important, for this is the end result of the work, where the composition receives it's final test, and actual perception of music can occur. And more often than not, musical compositions never reach this step, due to problems of lack of performers to interpret, or lack of proper instrumentation.

Thus, the need for a system to aid this process of creating and performing music- one which utilises machines to efficiently and quickly perform tasks which human hands of the past slowly execute. These machines are computers, capable of speeding the compositional process, performing the music, and expanding the musical field.

(2)

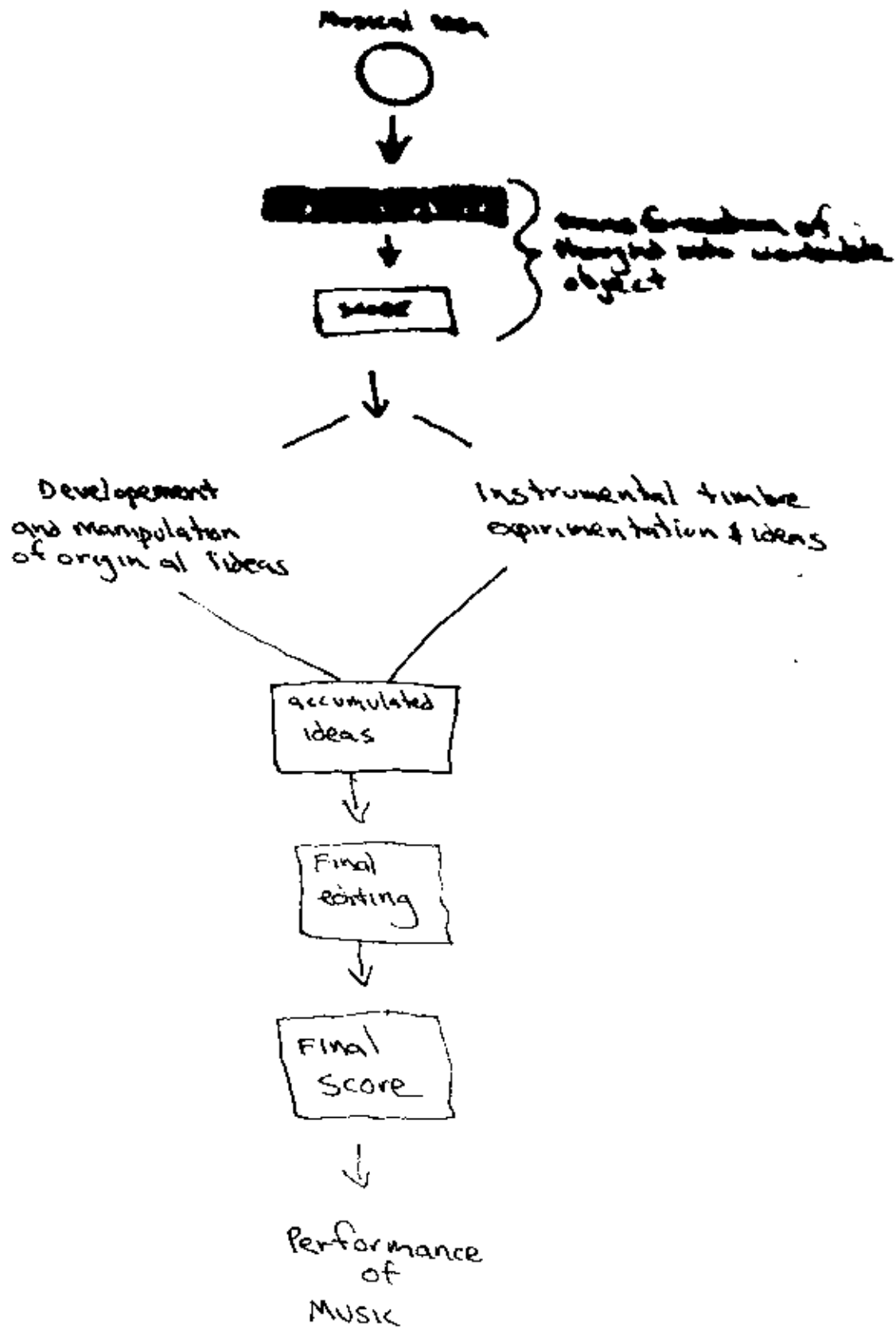


fig. 1 compositional process

Figure 1 graphs the compositional process, and presents the areas where computers can aid in this process. The system design for this task should be able to perform with as few limitations as possible, for music is a field that has no limitation. With this in mind, a system will be presented that can function within the areas specified on the graph, inviting technology to aid these areas.

### 1. COMPUTER AS COMPOSITIONAL AID

#### musical realisation

Musical inspiration should be realised as quickly and easily as possible. This means the idea should be quickly transformed to a visible, workable object. Computer aid here would be that of an interpreter of frequency presented by an interface of the mind and the computer. This interface could be a keyboard or any other instrument or oscillating device the composer wishes to use to present his ideas to the computer.



fig. 2

Ideally, the interface could be plugged into a system programmed to interpret pitches played into it into a visual language of musical notation. This visual notation could be displayed on a screen capable of displaying up to 3 separate voices. This presentation should not only display the represent notes, but also it's rhythmic duration in relation to other notes presented.

optical display

The display would be used to present portions of the composition being developed. These portions could be identified as SECTIONS, and further subdivided into smaller units called FRAMES. This would allow for ease in future recall of desired portions of the composition.

The keyboard (pitch producer) would specify to the computer the voice wished to be displayed, be it voice 1, 2 or 3, or any combination of the three. The voice would then be presented on one of three staves on the display. Octave identification would be realised by representative colors; black for the lowest octave specified, red for the next, and so forth. These colors would be used in the particular language the computer used; r G would be the note G in the red octave.



fig. 3 optical display

The clef would be an optional note range specified before pitch input. this would prevent notes running off the clef, crowding the display screen.

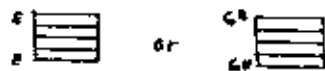


fig. 4

Note the top voice in figure 3. While voices 2 and 3 display pitches presented within an equal temperament octave, voice 1 shows a display of an oscillator input, which would be an option of the display system. This linear display also uses the color octave system. The displayed voice in fig. 3 is alternating between two octaves in frames 1-4.

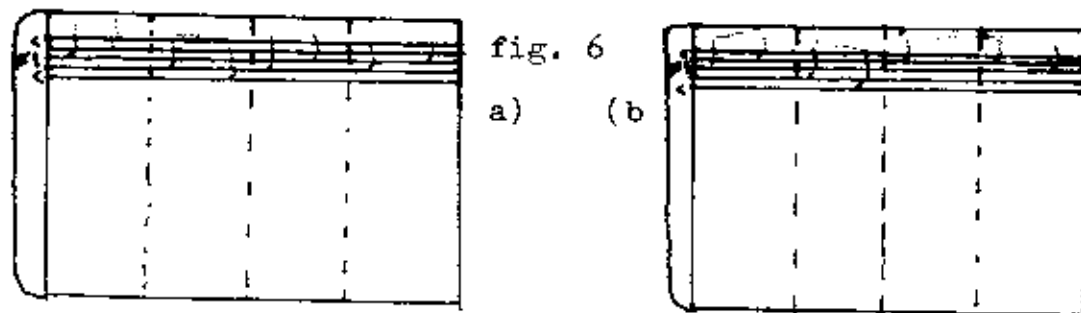
The size of the screen is another factor to consider. For mere section display, the screen need not be too large. But the screen should be large enough to display more than one section of the composition simultaneously, so that other sections of the piece stored in memory could be called for comparison, on a smaller scale.

#### storage of sections

When a section has been satisfactorily developed, it should be easily placed in memory of the computer, which, when the need for future reference or manipulation arises, it can be easily recalled. Each section would be assigned a call number, and would be coded in memory via a master computer keyboard. This procedure should contain as few steps as possible, without the need of computer cards. The computer would be programmed to convert a displayed section of musical notes to an alphanumeric language, and place in memory, all with the flip of a switch on the master keyboard, and recalled to display just as easily.



Editing procedures would involve usage of both screens simultaneously- commands being issued through the master keyboard, while sections being manipulated would be displayed on the optical display unit. To describe the edit function and a computer conversation, we will edit a given section (figure 6)



We want to change the last two notes of frame three and the first note of frame four from the original section to a C pedal note in a lower octave. The conversation on the master keyboard would read as follows:

a)  
1 SEC- 15  
2 FRAME- 3  
3 EDIT- CLEAR FR  
4 ADD- (b) C  
b)  
1 FRAME- 4  
(2)EDIT- C  
3 ADD- (b) C(8)  
STORE

Step 3 cleared the entire frame with a CLEAR command, and figure b displays the completed edit, which is now prepared to go back in memory, with the command 'STORE'.

(note- symbols next to notes show the need of a language to describe note values in time, duration, and octave, but the given symbols are theoretical in nature, and do not represent any language developed for this system.) The functions of ADD and JOIN would be executed in a similar manner of conversation through different command specifications. These procedures are important steps in composition and with easy recall and manipulation, computerised systems would allow for ease and speed in these areas.

#### Instrumentation

With a rough draft of a composition stored in memory, we are now ready to begin with procedures involving desired timbre for given voices. With a section of the composition on display, we can assign an instrumentation by a preconceived code next to the voice, which will continue until a new timbre is desired. This code would contain information specifying the instrument performing the voice, and a patch code for the desired timbre. This information would be stored in a memory 'B' in the computer. (New instrumental patch codes are entered via the master keyboard. The process of instrumental assignment would be run through the master keyboard in a manner such as :

CALL- sec 15  
 VOICE- 3  
 FRAME- All  
 INS- 6  
 PATCH- P- 08- 015

All instruments available are assigned a code name, which is registered in the computer, along with the available patch codes for that instrument. Instrumental manipulations are easily performed in the same manner as compositional manipulation, which readily allows for sound experimentation through the main terminal.

#### Score Production

With the assignment of instrumental voices complete, a finished composition has been acquired, but is still stored in the computer's memory. Now the computer is able to eliminate the tiresome, time consuming task of copying the final manuscript. With the addition of a compiler, run by the computer, the composition stored in memory can be printed out with a mere PRINT command issued through the master keyboard. The final sections, in sequential order in memory, would be translated by the computer in either a traditional notation, or in a computer language, by which the computer analyze and perform the score. (see next section)

With this type of function within the system, an immense amount of time and energy spent copying scores would be saved.

#### The Computer as a Performer

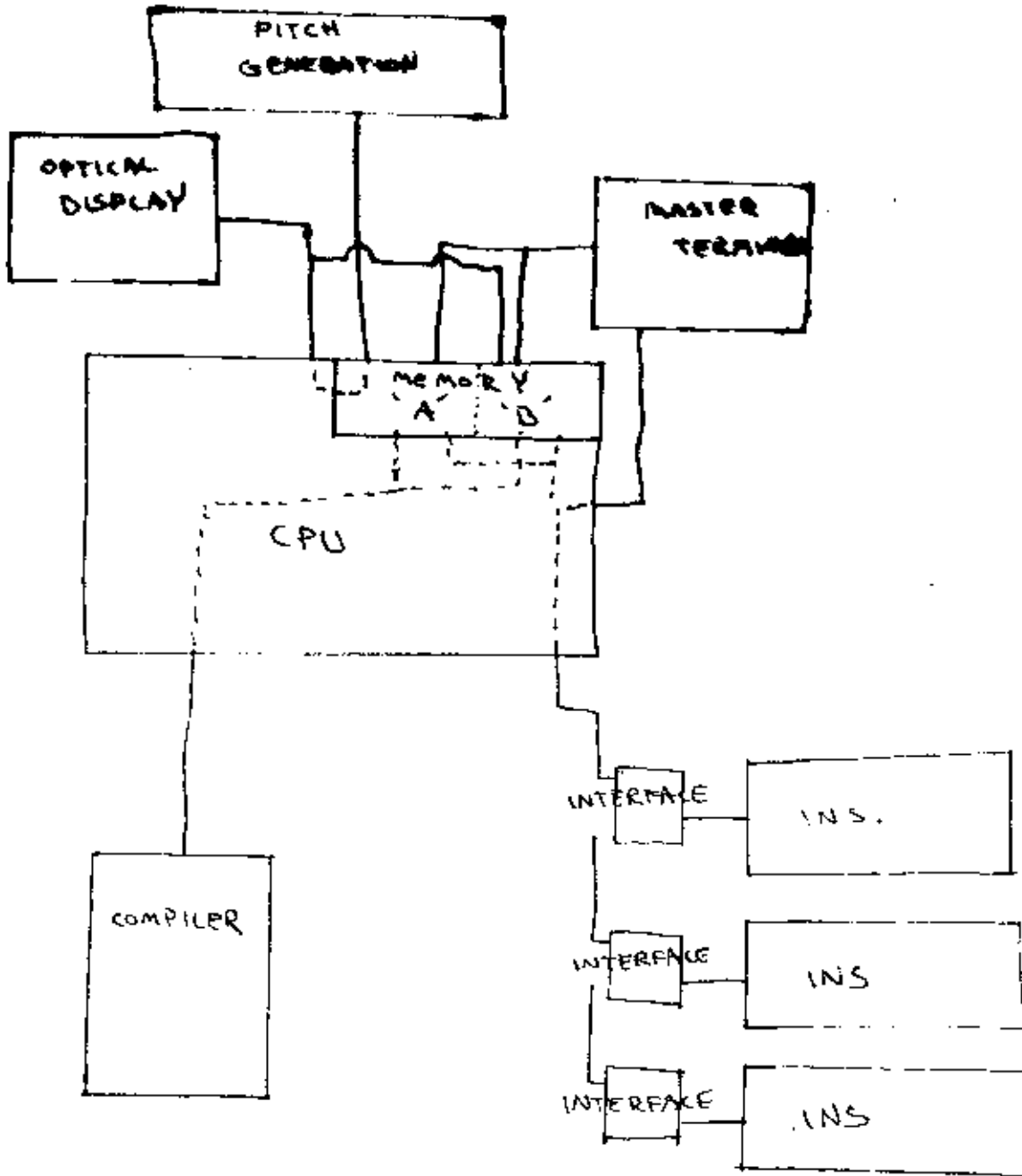
The most important and satisfying part in creating

music lies within the aural perception of the finished product. The final testing is where one realizes if the work is successful. However, more often than not the final product is never heard, due to performance problems, and therefore the work goes down the drain. This is the area where the computer can aid in an easy, non-rehearsed performance of the final score.

The system being described is largely theoretical, therefore we need not mention specifics in instruments, but instead recognize the importance of computer driven instruments within such a system. Through the specifics in the score, the computer would recognize the instrument, and would operate an interface to the instrument. An interface could be a solenoid operated keyboard, RCB's, or whatnot, pending on the available instrument.

The usage of the computer as a performer is perhaps the most outstanding usage of the computer within the musical field. All preceding computer usages were of a labor saving nature in the preparation of a score: now we have a machine which can quickly, effortlessly, and perfectly perform a score. This eliminates the gross tragedy of the musical world: not experiencing one's own work.

COMPUTERISED FLOW SYSTEM





CRT

PROGRAMMING/CONFIGURATION

