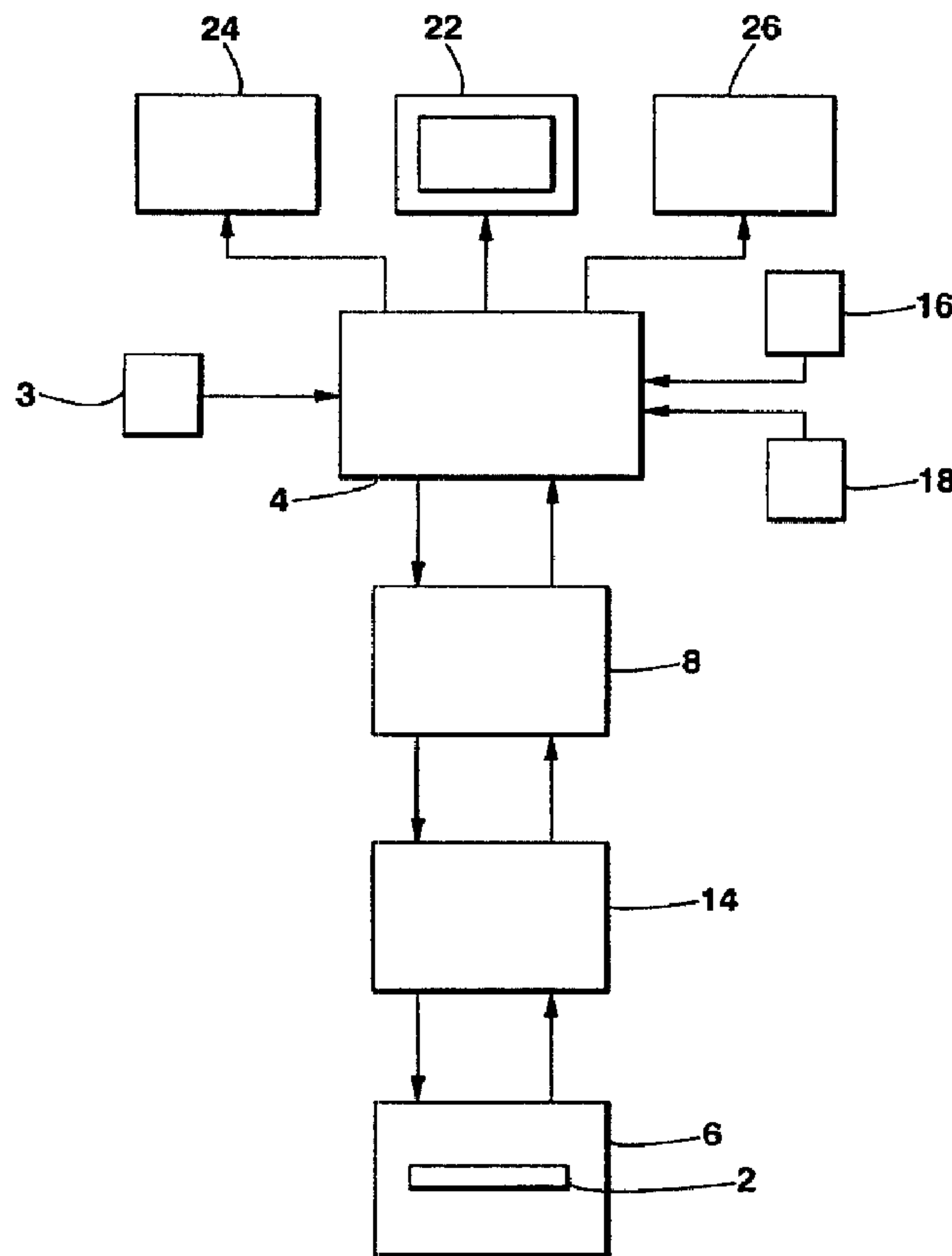




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(57) Abrégé/Abstract:

Digitized information can be automatically re-edited to alternate sequence characteristics or lengths with a marker file provided to a computer. Information that can change the characteristics of the digitized information is contained in the marker file and is a variable that can automatically control the digitized information stored in the memories. The disclosed procedure involves

(57) **Abrégé(suite)/Abstract(continued):**

assigning identification markers for points in a digital information file of a certain length containing digitized information. The markers may be assigned relative to the frame number from the beginning of the digital information file. The sections defined by the markers are then re-assembled automatically in other orders, output characteristics or in other sequences to create a new digital information file of different structure, characteristic and length. The technique is especially useful for producing musical rearrangements in the cathode ray tube screen and audio synthesizers.

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ABSTRACT OF THE DISCLOSURE

Digitized information can be automatically re-edited to alternate sequence characteristics or lengths with a marker file provided to a computer. Information that can change the characteristics of the digitized information is contained in the marker file and is a variable that can automatically control the digitized information stored in the memories. The disclosed procedure involves assigning identification markers for points in a digital information file of a certain length containing digitized information. The markers may be assigned relative to the frame number from the beginning of the digital information file. The sections defined by the markers are then re-assembled automatically in other orders, output characteristics or in other sequences to create a new digital information file of different structure, characteristic and length. The technique is especially useful for producing musical rearrangements in the cathode ray tube screen and audio synthesizers.

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## REARRANGING ARTISTIC COMPOSITIONS

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BACKGROUND OF THE INVENTION

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This invention relates to rearranging digital information with the use of a computer. In one aspect, the invention relates to rearranging sections of a music soundfile.

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Many applications, such as multimedia, or radio and television advertisements, require set-length audio tracks to be produced. The usual method of doing this uses analog equipment. Audio tape is physically sliced with razor blades and reassembled to the desired length or recombined in a different order. Obviously, this technique is very labor-intensive and time-consuming. It also requires a high level of aural training. A technique which eliminates the need for musical skills in the sound editing process would be very desirable.

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Each rearrangement of a musical composition using the prior art techniques as above required investments of time and training. A technique to cut down on the time and training required to produce rearrangements is needed.

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The production of alternative versions of a rearrangement is often impractical using the prior art techniques because of time and expense constraints. While other computer music editing programs allow the user to manipulate digitally sampled audio data, the user must still make decisions about where edit points will be and in what order to rearrange the resulting pieces. The user must ensure that the final product comes as close as possible to the desired length.

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A technique to automatically generate new versions of a rearrangement having different musical characteristics and/or length would be very desirable.

SUMMARY OF THE INVENTION

In one embodiment of the invention, there is provided a process for forming a tool which can be used for the rearrangement of digital information files, such as music files. To practice the process, there is provided a digital information file and a digital instruction file which correlates to information in the digital information file. Appropriate edit points for the digital information file are determined and marker points are assigned to the instruction file which correlate to the previously determined edit points for the digital information file. The instruction file is then stored. The process is characterized in that the digital information file is of an artistic composition having continuity and structure and the edit points divide the artistic composition into units each having continuity and structure. When used with soundfiles, MIDI files, (Musical Information Digital Interface files), or motion image files, the process results in the identification of "blocks" of digital information which can be used to produce rearrangements of the original. When the edit points are professionally chosen, rearrangements based on the blocks will be as high in quality as if the new version was constructed by the professional editors themselves.

In another embodiment of the invention there is provided a process for rearranging a digital information file. To practice the process, there is provided a digital information file and a digital instruction file which divides the digital information file into a first arrangement of digital information units. A plurality of the digital information units are combined to form a second arrangement of digital information units, each unit in the second arrangement being taken from the first arrangement. The process is characterized in that the digital information file is of an artistic composition having continuity and structure and the digital instruction file comprises a plurality of predetermined markers. The location of the markers is based on artistically appropriate edit points for dividing the digital information file into a plurality of units. Each unit should have structure and continuity, and a beginning and an ending

denoted by a marker. The process is especially useful for rearranging music as well as other art forms that lend themselves to recombination, such as video and animation. When the edit points have been professionally predetermined for a soundfile, for example, it is a simple matter for a relatively untrained technician to produce a rearrangement having professional quality. The time required to produce the rearrangement is much less than would be required by highly skilled professionals using prior art techniques. When the process is carried out on a high speed computer, it is generally possible to produce a multiplicity of rearrangements for any given length. Further, in the case of music, the process does not require the user to be knowledgeable in any capacity about music editing practices or music theory.

In yet another embodiment of the invention, there is provided a system for forming an instruction file for use in rearranging an artistic composition. Suitable artistic compositions are those having structure and continuity which are dividable into units each having structure and continuity by edit points. The system includes a computer. A digital information file containing the artistic composition is operatively associated with the computer. At least one output user interface is operatively associated with the computer for outputting information relating to the composition from the computer to a user. Retrieval instructions are provided for causing the computer to retrieve and output the information relating to the composition to the user through the at least one output user interface. Instructions are also provided for causing the computer to establish sample addresses for the digital information file. An input user interface is operatively associated with the computer to enable a user to input edit points for the digital information file. Correlation instructions are provided for causing the computer to correlate a sample address for each input edit point. A computer memory means is operatively associated with the computer for storing the sample addresses correlated with the edit points. Storage instructions are provided for causing the computer to store the sample addresses in the memory means. The system is characterized by instructions for causing the computer to repeatedly output selected units in

a loop through the at least one output user interface. By using the system to repeatedly play the units in this manner, the accuracy of the edit points can be verified.

5 In yet another embodiment of the invention, there is provided a process for using a computer system as just described. The process is characterized by the steps of inputting edit points to identify the beginning of units of the digital information file which form an appropriate beginning for a rearranged composition and  
10 executing the storage instructions. This results in the production of an instruction file which is easy to use for the making of artistically rearranged compositions.

In another embodiment of the invention, there is provided a system for  
15 rearranging an artistic composition having structure and continuity to form a new version. The system includes a computer, a digital information file, an instruction file, and a user interface. The digital information file of the artistic composition is operatively associated with the computer. The digital information file is one which is dividable into units each having structure and  
20 continuity by edit points. The edit points divide the digital information file into units each having continuity and structure. The output interface is for outputting digital information file units in a cognitive form to a user. The system is characterized by the instruction file. The instruction file comprises a computer memory, correlation instructions, and retrieval instructions. The  
25 instruction file is operatively associated with the computer and stores sample addresses which correlate with appropriate edit points for the digital information file. The correlation instructions correlate each sample address in the instruction file with the beginning of a unit in the digital information file for which it marks the beginning. The retrieval instructions are for causing the  
30 computer to retrieve for uninterrupted output through the output interface a plurality of units from the digital information file. The plurality of units

constitutes the new version of the composition. The system provides the user with the essentials for producing professional quality rearrangements.

In yet another embodiment of the invention, there is provided a computer memory device  
5 containing a digital information file and an instruction file. The digital information file is for an artistic composition having structure and continuity. The instruction file tracks the digital information file and contains marker points which correlate with appropriate edit points for the artistic composition. In the case of musical compositions, a computer memory device can be produced containing professionally positioned marker points for  
10 any musical composition, subject to the rights of the owner of the copyright owner, of course. The number of new musical pieces which can be produced from such devices is nearly limitless.

More specifically, the present invention provides a method for using a computer to  
15 change a first arrangement of an artistic composition comprising a sequence of events and having artistic continuity and structure to a second arrangement of the artistic composition, the method comprising the steps of (1) inputting an information file to the computer, the information file including a definition of the sequence of events in the first arrangement, (2) inputting an instruction file to the computer, (3) selecting a parameter  
20 for a given characteristic of the second arrangement of the artistic composition, and (4) executing the instruction file in the computer, the instruction file including markers, the markers indicating the location of respective information units in the first arrangement. Each information unit includes a sequence of events from a first edit point at the beginning of an initial event in the information unit to a second edit point at the end of a  
25 terminal event in the information unit, each of the first and second edit points being overlaid on, or embedded in, the information file and selected from a plurality of

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artistically appropriate edit points in the artistic composition, the sequence of events in each information unit having artistic continuity and structure, the instruction file providing instructions for automatically assembling information units from the first arrangement of the artistic composition into one of a plurality of second arrangements of the artistic composition. The second arrangements each have artistic continuity and structure and a sequence of information units that is different from the sequence of information units in the other arrangements, the one second arrangement having a given characteristic that satisfies the selected parameter.

10 The present invention also provides a method for using a computer and an information file input to the computer to form an instruction file for use in changing a first arrangement of an artistic composition comprising a sequence of events and having artistic continuity and structure to a second arrangement, the information file including a definition of the sequence of events in the first arrangement, the computer having an  
15 input interface for providing input to the instruction file and fixed or removable memory for storing the instruction file, the computer having at least one output interface for displaying information from a file, the method comprising the step of, (1) providing markers to the instruction file, the markers indicating the location of respective information units in the first arrangement, each information unit including a sequence of  
20 events from a first edit point at the beginning of an initial event in the information unit to a second edit point at the end of a terminal event in the information unit, (2) selecting the first and second edit points for each information unit from a plurality of artistically appropriate edit points in the artistic composition, the sequence of events in each information unit having artistic continuity and structure, the instruction file providing  
25 instructions for automatically assembling the information units into one of a plurality of second arrangements of the artistic composition, the second arrangements each having

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artistic structure and continuity, and a sequence of information units that is different from the sequence of information units in the other arrangements, and (3) providing instructions for automatically assembling markers defining a sequence of information units into a second arrangement of the artistic composition having a given characteristic satisfying a selected parameter for the given characteristic input to the computer by a user when the instruction file is executed by a computer to produce the second arrangement, the second arrangement satisfying the selected parameter having artistic continuity and structure.

10 The present invention also provides computer apparatus for use in changing a first arrangement of an artistic composition, comprising a sequence of events and having artistic structure and continuity, to a second arrangement using computer memory means including an information file having a definition of the sequence of events in the first arrangement, and an instruction file, the computer apparatus comprising an input interface operatively associated with the apparatus for, (1) obtaining markers from the instruction file, the markers indicating the location of respective information units in the first arrangement, each information unit including a sequence of events from a first edit point at the beginning of an initial event in the information unit to a second edit point at the end of a terminal event in the information unit, each information unit having a respective unit length from the first edit point to the second edit point in the information unit, each of the first and second edit points in each information unit being overlaid on, or embedded in, the information file and selected from a plurality of artistically appropriate edit points in the artistic composition, the sequence of events in each information unit having artistic continuity and structure, the instruction file providing instructions for automatically assembling information units from the artistic composition into one of a plurality of second arrangements of the artistic composition, the second arrangements

5c

each having artistic continuity and structure and a sequence of information units that is different from the sequence of information units in the other arrangements, (2) obtaining a parameter for a given characteristic selected by a user, and (3) obtaining a signal initiating execution of the instruction file in the computer, the instruction file using the selected parameter so as to assemble a second arrangement of the artistic composition, wherein the given characteristic of the one second arrangement satisfies the selected parameter and the second arrangement has artistic continuity and structure. An output interface is operatively associated with the apparatus for assembling the one second arrangement in a new version file.

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The present invention also provides computer apparatus for using an information file for forming an instruction file on computer memory means for use in changing a first arrangement of an artistic composition, comprising a sequence of events and having artistic structure and continuity, to one of a plurality of second arrangements, the information file including a definition of the sequence of events in the first arrangement of the artistic composition. The computer apparatus comprises an input interface and at least one output interface, the input interface being operatively associated with the apparatus for selecting first and second edit points at the beginning and at the end of the events in each information unit, respectively, from a plurality of artistically appropriate edit points in the artistic composition for storage in the instruction file, the events in each information unit being a sequence of events having artistic continuity and structure, the output interface being operatively associated with the apparatus for retrieving the first arrangement using the information file and displaying the first arrangement in a cognitive form suitable selecting the first and second edit points for each information unit, and retrieval computer program code means for causing the computer to retrieve and output the first and second arrangements of the artistic composition through the output interface.

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The computer apparatus further comprises address correlation computer program code means for causing the computer to identify addresses where the sequence of events included between the first edit point and the second edit point in a given information unit can be retrieved from the first arrangement using the information file, storage instructions  
5 for causing the computer to store information specifying edit points selected for a marker in the instruction file, and instructions for assembling the one second arrangement in a new version file, the instructions including instructions for implementing a parameter selected by a user for a given characteristic in the one second arrangement when the one second arrangement is assembled, so that the given characteristic in the one second  
10 arrangement satisfies the selected parameter and the one second arrangement has artistic continuity and structure.

#### BRIEF DESCRIPTION THE DRAWINGS

The Figure schematically illustrates certain features of various embodiments of the  
15 invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The term "edit point" is intended to mean a point in an artistic composition which a human editor has determined is an appropriate breaking point in the flow pattern  
20 between two adjacent passages or sections in the artistic composition. In the case of music, the edit points are preferably selected to correlate with zero crossings in a display of the audio waveform of the music. The zero crossing is intended to mean the point on the display where a pulse of (+) electrical sign is shown to cross the horizontal axis of the display to become a pulse of (-) electrical sign, or vice versa. The  
25 term "marker point" is intended to mean a stored point in computer memory or a computer memory device which correlates with a selected edit point. The marker points

can be imbedded in the information file which stores the artistic composition, or stored in a different information file. Where the marker points are stored in a different information file, the marker points generally represent a measurement of time from either the beginning of the composition or from another marker point. In the case of digitized music, it is convenient for the marker points to represent frame number, preferably a frame number at which a zero crossing occurs. The marker points are used to divide the information file containing the artistic composition, which is preferably in digital form, into "sections" or "blocks" of information between markers from which new versions of the artistic composition may be formed using recombination techniques.

In one embodiment of the invention, there is provided the combination of a digital information file and a digital instruction file. The digital information file is for an artistic composition having structure and continuity, such as a music or a motion image work. The digital instruction file tracks the digital information file and contains marker points which correlate with appropriate edit points for the artistic composition. In a preferred embodiment, the digital information file and the digital instruction file are supplied on a compact disc 2, although they can be separately provided and accessed using the system or process of the invention and provide good results. The combination is useful for producing rearrangements of the digital information file.

Although it is believed that the invention will have its greatest application in rearranging music, it is expected to have application for such things as choreographing dance routines and arranging marching band routines as well as to provide data for virtual reality games, and educational and entertainment games, and for training simulators such as for aircraft. The images of the motion image file can thus be of real life figures, caricatures, blocks, stick figures etc., depending on the application.

The Figure illustrates a system which can be used to practice certain embodiments of the invention. In forming the inventive combination, a magnetic tape reader 3, such as a DAT machine, is generally operated in conjunction with a computer 4, although a compact disc reader could generally be used if desired. The computer 4 is operably associated with a random access computer memory means 8 and a hard drive 14. The computer 4 is provided with instructions to cause the computer to transfer the digital information from the magnetic tape reader to the hard drive. The term "instructions" as used herein, means instructions to cause a computer to perform a task. The instruction file operates in the random access memory 8, accessing the digital information file in the hard drive as needed. Preferably, the digital information file comprises a plurality of digital information frames of digital samples, each digital information frame being identifiable by a frame number.

The system also includes various user interfaces 16, 18, 22, 24 and 26 which can be categorized as input user interfaces and output user interfaces. At least one input user interface is electronically coupled to the computer for inputting instructions from a user to the computer to cause the computer to execute instructions. At least one output user interface for outputting the digital information file units to a user in a cognitive form is electronically coupled to the computer for outputting the information received from the digital information file. Preferably, the input user interfaces comprise a mouse 16 and a keyboard 18. The system also includes output user interfaces 22, 24, and 26 electronically coupled to the computer for outputting audio and visual information from the computer to the user. In the illustrated embodiment, the output user interfaces comprise a cathode ray tube screen 22 and audio synthesizers 24 and 26.

The system just described can be used to form a marker file portion of the digital instruction file. The marker file comprises a plurality of predetermined markers based on artistically appropriate edit points for dividing the digital

information file into a plurality of units, each unit having structure and continuity and having a beginning and an ending denoted by a marker. In the preferred embodiment, each digital information unit is comprised of a sequence of events and the markers are assigned to mark a starting event for the sequence of events. In a particularly preferred embodiment, the digital information file comprises a soundfile or a MIDI file of a musical composition or an imagefile of a motion image work. The events in the sequence of events are tones in the case of the soundfile or MIDI file and images in the case of the imagefile.

Each starting event in the case of the soundfile or MIDI file is capable of being expressed as a point in a measure of music. Each edit point in the case of the imagefile is capable of being expressed as a starting position for a first event in a sequence of images forming a unit. For soundfiles, at least a major portion of the marker points, preferably substantially all of the marker points, are assigned to mark the beginning of a musical section of the soundfile which forms an appropriate beginning for a musical composition. The marker points for the soundfile should be validly chosen so that rearrangements will be artistically pleasing. Where the soundfile is pulse code modulated and has an audio waveform, the marker points are generally assigned to the zero crossings in the graphical view of the audio waveform of the soundfile. This is conveniently accomplished by displaying the audio waveform on the cathode ray tube 22 while outputting the music through the synthesizers 24 and 26. Appropriate edit points for the digital information file are determined and marker points are assigned to the instruction file, preferably by frame number. The marker points correlate to the previously determined edit points for the digital information file and are input through the mouse 16 or keyboard 18.

Further in the case of music it is desirable to have short musical sections or blocks available for incorporation into the new version file to trim length. Repeated sections of music in the original version can be broken up to provide this. Where the soundfile contains at least one repeated musical

section, marker points are preferably assigned to subdivide one of the repeated musical sections into measures. The appropriateness of the edit points can be checked by repeatedly playing the musical section of the soundfile determined by the edit points in a loop, and to this end, it is preferred that the computer be further provided with instructions for causing the computer to repeatedly output selected units in a loop through the at least one output user interface so that the accuracy of the edit points can be verified. The instruction file and completed marker file is collected or assembled on the hard drive for eventual transfer to a read only memory device, optionally with the digital information file. Generally speaking, the digital information file together with the digital instruction file will be transferred to a CD-video or CD-audio device, because these types of computer memory devices are commercially available, although other forms of computer memory devices could be used as well.

To use the system to rearrange digital information files, there is provided a digital information file and a digital instruction file which tracks the digital information file. The required information can be conveniently supplied by the memory device 2. For rearranging applications, the computer is generally operated in conjunction with a compact disc reader 6 which contains the compact disc 2. The computer 4 is provided with suitable instruction means to cause the computer to transfer the digital information file and the instruction file from the compact disc to the hard drive 14. The instruction file is transferred to the random access memory means 8. The system is used by executing the instructions in the instruction file.

In a particularly preferred embodiment, the instruction file includes correlation instructions and retrieval instructions. The correlation instructions correlate each sample address in the instruction file with the beginning of a unit in the digital information file for which it marks the beginning. The retrieval instructions are for causing a computer to retrieve for uninterrupted output

through user output interface a plurality of units from the digital information file.

5 In one embodiment of the invention, the instruction file includes unit length information associated with the sample addresses for the beginning of the units; instructions for establishing a new version file containing a plurality of sample addresses together with length information; instructions for specifying a desired length for the new version file; instructions for calculating remaining available space in the new version file; instructions for automatically identifying a candidate unit to be considered for filing in the new version file based on the sample address and length information and available space in the new version file; and instructions for filing in the new version file the sample address and length information relating to a candidate unit which will fit into the remaining available space in the new version file. This information enables 10 a computer, such as a 386 or 486, to automatically construct new versions of the digital information file.

20 Because an objective of one embodiment of the invention is to provide new versions of a specified length it is further desirable to provide the digital instruction file with instructions for iteratively filling the new version file with the sample addresses and length information relating to candidate units which will fit into the remaining available space in the new version file until the available free space is within predetermined limits of the desired length of the new version file.

25 Where the digital information file comprises a soundfile of a musical composition and the digital information units comprise blocks of the soundfile this aspect of the invention can be carried out by selecting a desired time of performance for the second arrangement. The instructions automatically select the digital information units for combination so that the second arrangement 30 will have about the desired time of performance.

Generally speaking, the original version can be characterized as a first arrangement of a first set of data blocks and the new version can be characterized as a second arrangement of a second set of data blocks. The first arrangement will generally have a first musical structure and the second arrangement will generally have a second musical structure. However, to provide a musically pleasing ending to new versions of musical composition, it is desirable to position the ending unit in the original version as the ending unit in the new version. Thus, instructions for determining position information about a unit relative to other units in the digital information file and instructions for positioning the ending unit of the digital information file as the last unit in the new version file are also preferred to be present in the instruction file. Preferably, instructions for causing the ending unit of the digital information file to be the first unit to be positioned in the new version file are also included. Although most any unit can be positioned as the opening unit in the new version, it is desirable to begin the new version with the same beginning as the original version. Thus, instructions for positioning the beginning unit of the digital information file as the beginning unit in the new version file are also preferably present. Most preferably, the beginning unit is the second unit to be positioned in the new version file. It is further desirable to preserve the flow of the original composition for musical rearrangements. Thus instructions for causing the progression of units in the new version file to generally follow the progression of the units in the digital information file are also preferably included in the instruction file. The order of progression is only generally followed, however because the algorithm permits the same digital music block from the first arrangement to appear in the second arrangement at more than one position and will perform iterations when the second arrangement is longer than the first arrangement or alternative versions are desired.

In one embodiment of the invention, each block in the original version of the soundfile carries frequency and amplitude information in digital form. By modulating the amplitude information when the blocks are recombined, the

first arrangement will have a first set of musical characteristics and the second arrangement will have a second set of musical characteristics.

5 In the most preferred embodiment of the invention, the instruction file further includes at least one classification file based on a common characteristic of the digital information file at certain starting events. Each such classification file is based on a single common characteristic. Each starting event in the case of the soundfile or MIDI file is capable of being expressed as a point in a measure of music. For these compositions, the common characteristic is the point in the measure which marks the beginning of the unit. Each starting event in the case of the imagefile is the starting position for the first event in the sequence of images forming the unit. The common imagefile characteristic is the starting position for the first event in the sequence. Also included are instructions for causing the computer to file at least two of the sample addresses which correlate to units having the common digital information file characteristic in their respective classification file; instructions for causing the computer to correlate the sample addresses in the classification file with the units of the digital information file; and instructions for causing the computer to retrieve and output to a user through user interfaces the units indicated by the sample addresses. More pleasing rearrangements can be formed when the plurality of digital information units combined to form the second arrangement are from the classification file.

25 Various aspects of a preferred embodiment of the invention are further described in the following example.

### EXAMPLE

#### Background

30 The marker files of each piece of music are created by a program referred to as Autoblade using the soundfile of the desired piece of music as a template for placing the markers at appropriate sample addresses. The marker files contain all the instructions needed by a program referred to as TuneBuilder

to perform its recombinances, and to alter the characteristics of the resultant new soundfile in various ways. The marker files as described in this example are therefore an "overlay" technology as opposed to an "embedded" technology.

5

The marker files do not directly interact with or alter the existing soundfile in any way. In addition, the marker files may be physically separated from the soundfiles without affecting the results. So long as the original soundfile does not change, Tunebuilder can use the marker files as instructions at any time, as long as both the soundfile containing the original information and the marker files containing the recombination instructions are accessible to TuneBuilder at the same time. The sound file and the marker files do not have to be distributed together.

10

15

#### What Autoblade does:

1. Identifies and marks a position on the soundfile relative to the beginning of the soundfile. This position is accurate to the sample, which in this case is 1/44,100 of a second.

20

2. Allows for the assigning of marker points to different families or classifications.

3. Automatically joins edit points to other edit points in the same family.

25

4. After the program recombines the sections into a new duration, AutoBlade adjusts for changes in dynamic level from one section to another.

30

5. Allows a marker point to be placed and moved on the screen while listening to the music track.

6. Allows for a compensation in the placing of the marker point while listening, equivalent to a user's reaction time.

7. Prepares a marker file set (instruction file) that is readable by TuneBuilder.

5 TuneBuilder is a playback program discussed below that creates new recombinations of the musical sections that will meet a predetermined duration criteria.

#### The Procedure.

10

Each piece of music (hereafter called a track), is a digitally sampled version of the music. It is usually first recorded onto DAT (digital audio tape). The digital data is then transferred into a sound file and transferred to hard disc. The format of the sampled data in the sound file is uncompressed PCM (pulse-code modulation) in 16-bit stereo samples, sampled at a rate of 44100 Hz, although the algorithm is applicable to virtually any format of data. In our process, we directly transfer the raw soundfile that exists on CD Audio, converting to an acceptable file format on the transfer. This file is then converted to the AIFF soundfile format.

20

The sound file is then loaded into Autoblade, which displays a graphical view of the audio waveform for each of the left and right channels. The program allows the editor to place a visible markers where the valid edit point is to occur. These markers are a reference to the sample frame upon which the edit point occurs.

25

The collection of markers created for the sound data file are specific to that version of the sound data file. Since markers are referenced by sample frame number, they are independent of the sound file format being used. The markers refer to the sample frame in the 44100 Hz original data, whether the end user uses a lower quality sound format or not. The proprietary editor program is a tool used only to create markers.

30

## Usage of Autoblade

1. There are various edit criteria that will exist simultaneously in each piece of music. The first step is to identify these and group them into a finite number of families. For example, there may be a family of edit points on "downbeats", another on beat "2 and", and another family on the "beat one". There is the ability to create an unlimited number of families files AutoBlade.  
5
2. The family files are indicated by a different colored division lines on the viewing screen. Edit points are assigned to the desired family file by selecting the appropriate family file and placing the edit point into that family file. In other words, all the edit points on the "downbeat" are placed in a first family file, all the marker points on the "beat 2 and" are placed in a second family file, and all the marker points on "beat one" are placed in the third family file. Preferably, all the possible edit points in the music are identified, marked, and assigned to a family file. Some of the family files may have only two members.  
10  
15
3. If there are identical repeated sections, the first is cut into one bar phrases, the second in two bar phrases, the third In four bar phrases, etc.  
20
4. The white marker on the viewer is active. This is the marker used to find the correct edit point.
5. The edit can be checked by zooming to the appropriate level. The section on either side of the marker can be selected by clicking the left mouse on it then playing with the right mouse button.  
25
6. To check position, the entire window can be played. left edge up to selected marker, or after selected marker to window right edge, or by drag and play.  
30

7. The program stores itself every 15 minutes or at any other predetermined frequency.

8. Some ways to quickly check accuracy of the edit:

- 5           a.     Loop the section two or three times and listen to how musical it is.
- b.     Listen for a click at the end of the section. This means the cut has been made into the attack of the next beat or the cut has not been placed at a zero crossing. (This is generally audible to the sample, 10           1/44,100 of a second.)
- c.     Randomly select sections, string them together and check the results.

9. In each family of marker points, the cut should always be made to the 15     same position on the rhythm.

10. It is possible to cut to less than a measure and consider it as an edit family, as long as the cut is on the same position on the rhythm as every other cut contained in the other family members.

20

11. In a related point to number 2; if there are repeating sections, the first is desirably cut every two bars, the next every bar, and the next every two beats. The short sections are useful since the recombination instructions in Tunebuilder call for small segments as well for the shorter automatic edit 25     lengths.

### TuneBuilder

30

The algorithm used to construct new versions takes into account the required length, how many versions have been previously generated for the specified

length, number of markers in the original track, and the length of original track.

5 The user first chooses which track they want to edit. Digital data for each track may be distributed on CD-ROM (Compact Disc Read-Only Memory) in both CD-Audio (also known as Redbook format) and sound file versions (digital audio sample data stored in computer files on disc). Once the user chooses which track they want to work with, sound file data and associated marker data for it are copied from CD-ROM onto the user's hard disc drive.  
10 In original sound quality (16-bit stereo 44.1 KHz), each minute of audio data takes 10.584 Mb of disc space.

The user then specifies what length they want the new version to be. This length can be specified in seconds, video frames (30/sec), film frames (24/sec),  
15 or beats (from beats per minute value precalculated for the chosen track). This length value is then converted to a decimal seconds value by the software for internal calculations.

The algorithm keeps a total of how much free space is left in the desired  
20 length specified by the user. Each time a block is added to the new version, length of the block is subtracted from the total. When there is no space left, the algorithm recognizes that it is done, and the new version is ready for the user. The new version is represented as a list of blocks in a particular order. When constructing a new version, the initial state of the list is empty, and new  
25 blocks are added until desired length is reached.

The first block the program attempts to add to the list is the last block from the original track. This block is added at the end of the list so that it will appear as the last block in the new version. While almost any block can be  
30 used to create an acceptable beginning for a musical piece if the markers have been placed correctly, it is desirable to have the last block from the original version appear at the end of the new version. This is because in practice, not

all blocks can be used as end blocks and still sound acceptable. Adding the last block to the list before adding any other blocks ensures that if there is insufficient space to add more blocks to the list, the new version will still sound acceptable. If the specified length of the new version is shorter than the length of the end block from the original version, the block is not added to the list because it would make the new version longer than the specified length. The current value of the amount of free space left is decremented by the length of the block added to the list.

If there is still room, the algorithm then chooses the first block in the original track to add at the front of the list. (If this is not the first version generated for this specified length, or the specified length is relatively short, then the algorithm acts differently). The amount of free space left is decremented by the size of this block and the algorithm continues.

The algorithm continues to iterate in the same manner until all free space is used. The next block added to the list is the second last, the second, then the third last, and the third, and so on, choosing from alternate ends of the original version, moving towards the middle until the list is filled.

When the new version is to be longer than the original, the algorithm starts as above until all of the original blocks have been placed, then iterates through the original version again, skipping the end blocks in the original version, and continues until the new version file is filled.

When alternate new versions are desired, the algorithm starts as above, positioning the beginning and ending blocks, and then fills toward the center, skipping random blocks in the original version, until the new version file is filled.

Other orders of recombination are also possible within the algorithm. Priorities may be established using other criteria for the edit points, either

masking them from being used by the algorithm or by establishing relationships between two or more sections or groups of sections.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for using a computer to change a first arrangement of an artistic composition comprising a sequence of events and having artistic continuity and structure to a second arrangement of the artistic composition, said method comprising the steps of:
  - (1) inputting an information file to the computer, said information file including a definition of the sequence of events in said first arrangement;
  - (2) inputting an instruction file to the computer;
  - (3) selecting a parameter for a given characteristic of said second arrangement of the artistic composition; and
  - (4) executing said instruction file in said computer, said instruction file including markers, said markers indicating the location of respective information units in said first arrangement, each information unit including a sequence of events from a first edit point at the beginning of an initial event in the information unit to a second edit point at the end of a terminal event in the information unit, each of said first and second edit points being overlaid on, or embedded in, said information file and selected from a plurality of artistically appropriate edit points in said artistic composition, said sequence of events in each information unit having artistic continuity and structure, said instruction file providing instructions for automatically assembling information units from said first arrangement of the artistic composition into one of a plurality of second arrangements of said artistic composition, said second arrangements each having artistic continuity and structure and a sequence of information units that is different from the sequence of information units in said other arrangements, said one second arrangement having a given characteristic that satisfies said selected parameter.

2. The method of claim 1, wherein the given characteristics of said second arrangement is selected from the group consisting of a time duration, a time metric and a signal amplitude characteristic.
3. The method of claim 1 or 2, further comprising the steps of storing markers indicating information units selected by the instruction file for inclusion in said second arrangement of said artistic in a new version file, determining a cumulative characteristic of the information units indicated by said stored markers, and using said cumulative characteristic for automatically selecting another marker to be stored in said new version file.
4. The method of claim 1, 2 or 3, further comprising the step of calculating a time duration characteristic of an information unit indicated by a marker using the unit length of said information unit, wherein said parameter includes a time duration characteristic and said unit length is a distance between said first edit point and said second edit point.
5. The method of claim 4, further comprising the step of calculating a time duration characteristic of the information unit indicated by said marker using a respective unit length indicated by said instruction file as corresponding to said marker.
6. The method of claim 4, further comprising the step of using markers indicating first and second edit points of an information unit, respectively, for calculating a time duration characteristic for said information unit.

7. The method of claim 4, 5 or 6, further comprising the steps of calculating a remaining time duration characteristic for said second arrangement using respective time duration characteristics calculated for the information units indicated by markers selected for said second arrangement by the instruction file, selecting a plurality of information units having respective time duration characteristics suitable for filling the calculated remaining time duration, and storing markers indicating said selected suitable information units in a new version file.
8. The method of claim 7, further comprising the step of iteratively storing a marker indicating a selected suitable information unit so as to fill a remaining time duration of the second arrangement in a new version file with a given information unit.
9. The method of any one of claims 1 to 7, further comprising the step of using at least one classification file in executing said instruction file, said classification file including a plurality of markers for respective selected information units in the information file having a given common characteristic determining the suitability the information units indicated by respective markers in said classification file for a location in a second arrangement of an artistic composition, said instruction file selecting a marker from said classification file, said instruction file assembling the information unit indicated by said selected marker into a location in said second arrangement suitable for said given common characteristic.
10. The method of claim 9, further comprising the step of filling the remaining time duration in a second arrangement of the artistic composition in a new version file using

information units indicated by markers in a classification file including a given time duration characteristic.

11. The method of claim 9 or 10, further comprising the step of modifying the common characteristic of a selected information unit, wherein a time metric or signal amplitude characteristic at the beginning or end of an information unit is not common characteristic of a classification file from which the marker indicating said selected information unit was selected.

12. A method for using a computer and an information file input to the computer to form an instruction file for use in changing a first arrangement of an artistic composition comprising a sequence of events and having artistic continuity and structure to a second arrangement, said information file including a definition of the sequence of events in said first arrangement, said computer having an input interface for providing input to the instruction file and fixed or removable memory for storing the instruction file, said computer having at least one output interface for displaying information from a file, said method comprising the step of:

(1) providing markers to said instruction file, said markers indicating the location of respective information units in said first arrangement, each information unit including a sequence of events from a first edit point at the beginning of an initial event in the information unit to a second edit point at the end of a terminal event in the information unit;

(2) selecting said first and second edit points for each information unit from a plurality of artistically appropriate edit points in said artistic composition, said sequence of events in each information unit having artistic continuity and structure, said instruction file

providing instructions for automatically assembling said information units into one of a plurality of second arrangements of said artistic composition, said second arrangements each having artistic structure and continuity, and a sequence of information units that is different from the sequence of information units in said other arrangements; and

(3) providing instructions for automatically assembling markers defining a sequence of information units into a second arrangement of the artistic composition having a given characteristic satisfying a selected parameter for said given characteristic input to the computer by a user when said instruction file is executed by a computer to produce said second arrangement, said second arrangement satisfying said selected parameter having artistic continuity and structure.

13. The method of claim 12, wherein the given characteristic of said second arrangement is selected from the group consisting of a time duration, a time metric and a signal amplitude characteristic.

14. The method of claim 12 or 13, further comprising the step of indicating a unit length relative to an edit point in said instruction file corresponding to a marker indicating said information unit, said unit length being used by said instruction file to determine the location of the other edit point defining the length of said information unit.

15. The method of claim 12, 13 or 14, further comprising the step of calculating a time duration characteristic of an information unit indicated by a marker using the unit length of said information unit, wherein said parameter includes a time duration characteristic and said unit length is a distance between said first edit point and said second edit point.

16. The method of claim 15, further comprising the step of calculating a time duration characteristic of the information unit indicated by a marker using a respective unit length indicated by said instruction file as corresponding to said marker.

17. The method of any one of claims 12 to 16, further comprising the step of providing a plurality of digital samples in said information file, each event corresponding to a digital sample and each edit point in the information file corresponding to a sample address.

18. The method of claim 17, further comprising the step of selecting edit points in the information file that are each capable of being expressed as a point in a measure of music, wherein the information file is a MIDI file or interactive audio file for example.

19. The method of any one of claims 12 to 18, further comprising the step of assigning a sequence of events to each information unit, said markers indicating a starting event in each sequence of events, each starting event being determined by (a) observing a video display of the waveform of the information file, said video display having a horizontal axis and a vertical axis; (b) using said video display to select edit points within said information file such that said edit points are at null points where the waveform changes polarity so as to cross the horizontal axis of the video display, said edit points dividing said artistic composition into a plurality of information units, each of said plurality of information units having artistic continuity and structure; (c) assigning a marker to at least one of said selected edit points; and (d) storing said marker for use by said instruction file.

20. The method of claim 19, further comprising the step of selecting edit points in the information file that are each capable of being expressed as a respective starting point for movement in an image, wherein said information file comprises an image file of a motion picture, video, animation or virtual reality work wherein each event in the sequence of events comprises an image.

21. The method of any one of claims 12 to 20, further comprising the step of providing respective lengths to said instruction file for each of said information units.

22. The method of any one of claims 12 to 21, further comprising the step of assigning a sequence of respective frame numbers to each event in an information unit, each event corresponding to a given frame and each edit point in the information file corresponding to a respective frame number of a given frame in the information unit.

23. The method of any one of claims 12 to 22, further comprising the step of storing at least one marker in at least one classification file for use in executing said instruction file, marker indicating a selected information unit having a given common characteristic, said classification file determining the suitability of the information unit indicated by the marker for placement in a location in a second arrangement of the artistic composition by said instruction file, for example a common characteristic including a cumulative characteristic of time duration or a time metric or a signal amplitude, or an interface characteristic of time metric or signal amplitude at the beginning or end of an information unit.

24. The method of claim 23, further comprising the step of storing markers in said classification file indicating information units having the characteristic of being artistically user suited for use as a first or last unit in a selected second arrangement, respectively.

25. The method of claim 24, further comprising the step of storing markers in a classification file indicating information units providing the beginning or end information unit in sequences of information units in the first arrangement of said artistic composition said information file so that a majority of said information units in a classification file having the characteristic of being artistically suited for use as a first or a last unit in a selected second arrangement are information units providing the beginning or the end of sequences of information units in said first arrangement of said artistic composition.

26. The method of claim 21, further comprising the step of storing markers in said classification file indicating information units having the characteristic of being artistically suited for a given type of sequence with another information unit.

27. The method of claim 26, wherein the given type of sequence is the information unit before or after another information unit, or the information unit iteratively preceding or following itself.

28. An instruction file comprising a computer readable memory for storing programmable instructions for use in the execution in a computer of the method of any one of claims 12 to 27.

29. A computer-readable medium comprising a computer readable memory for storing programmable instructions to perform all the steps of the method defined in any one of claims 1 to 27.

30. Computer apparatus for use in changing a first arrangement of an artistic composition comprising a sequence of events and having artistic structure and continuity, to a second arrangement using computer memory means including an information file, having a definition of the sequence of events in said first arrangement, and an instruction file, said computer apparatus comprising:

an input interface operatively associated with the apparatus for

(1) obtaining markers from said instruction file, said markers indicating the location of respective information units in said first arrangement, each information unit including a sequence of events from a first edit point at the beginning of an initial event in the information unit to a second edit point at the end of a terminal event in the information unit, each information unit having a respective unit length, from the first edit point to the second edit point in the information unit, each of said first and second edit points in each information unit being overlaid on, or embedded in, said information file and selected from a plurality of artistically appropriate edit points in said artistic composition, said sequence of events in each information unit having artistic continuity and structure, said instruction file providing instructions for automatically assembling information units from said artistic composition into one of a plurality of second arrangements of said artistic composition, said second arrangements each having artistic continuity and structure and a sequence of information units that is different from the sequence of information units in the other arrangements;

(2) obtaining a parameter for a given characteristic selected by a user; and

(3) obtaining a signal to initiate execution of said instruction file in said computer, said instruction file using said selected parameter so as to assemble a second arrangement of said artistic composition, wherein said given characteristic of said second arrangement satisfies said selected parameter and said second arrangement has artistic continuity and structure; and

an output interface operatively associated with the apparatus for assembling said second arrangement in a new version file.

31. The computer apparatus of claim 30, further comprising a computer readable memory for storing programmable instructions that comprise program codes for use in the execution in a computer of the method of any one of claims 1 to 11.

32. Computer apparatus for using an information file for forming an instruction file on computer memory means for use in changing a first arrangement of an artistic composition, comprising a sequence of events and having artistic structure and continuity, to one of a plurality of second arrangements, said information file including a definition of the sequence of events in said first arrangement of the artistic composition, said computer apparatus comprising:

an input interface and at least one output interface, said input interface being operatively associated with the apparatus for selecting first and second edit points at the beginning and at the end of the events in each information unit, respectively, from a plurality of artistically appropriate edit points in said artistic composition for storage in said instruction file, said events in each information unit being a sequence of events having artistic continuity and structure, said output interface being operatively associated with the apparatus for retrieving said first arrangement using said information file and displaying said first arrangement in a cognitive form suitable selecting said first and second edit points for each information unit;

retrieval computer readable memory for storing programmable instructions that comprise program codes for causing the computer to retrieve and output the first and second arrangements of the artistic composition through said output interface;

address correlation computer readable memory for storing programmable instructions that comprise computer program codes for causing the computer to identify addresses where the sequence of events included between the first edit point and the second edit point in a given information unit can be retrieved from the first arrangement using the information file;

storage instructions for causing the computer to store information specifying edit points selected for a marker in said instruction file; and

instructions for assembling said one second arrangement in a new version file, said instructions including instructions for implementing a parameter selected by a user for a given characteristic in said one second arrangement when said one second arrangement is assembled, so that said given characteristic in said one second arrangement satisfies said selected parameter and said one second arrangement has artistic continuity and structure.

33. The computer apparatus of claim 32, wherein the given characteristic said second arrangement is selected from the group consisting of a time duration, a time metric or a signal amplitude characteristic.

34. The computer apparatus of claim 32 or 33, further comprising a computer readable memory for storing programmable instructions that comprise program codes for use in the execution in a computer of the method of any one of claims 11 to 27.

**Fig. 1**

