Music in the Digital Age

The movement of the music industry into the "Digital Age" marks a revolution in the quality of the reproduction and the versatility of music distribution. The digital language of computers has been incorporated into nearly every aspect of our lives, including audio and visual entertainment (e.g. CDs, DVDs digital cable, digital cameras, the World Wide Web). In order to for us to take advantage of digital music and the versatility it can provide, it may help us to understand some of the features of digital encoding of musical information, along with a discussion of tools that can be used to manipulate and process digital music.

Recorded Music. Music occurs when sound waves produced by voices, instruments or speakers lead to compression of air and the resulting response of the listeners' ears. Thus music has a source (speakers, voices, instruments), a transfer medium (usually air for humans, although water works great for whales and dolphins), and a receiver (ears or a microphone connected to a recording device). Music is created in live performances, which can be recorded for performance later. In order for a source of music to act on the transfer medium, physical movement of air must occur. The loudness of the music is determined by the amplitude (the amount of movement) of the source. The musical notes are determined by the frequency (the number of vibrations per second) of the source. Overtones, or frequencies at multiples of the base frequency, are also present and add to the quality of the sound. If we consider recorded (or computer generated) music, then the speakers that produce the sound must be activated by a series of voltages that control the amplitude and frequency of movement of the speakers. In traditional analog music recording, these voltages are encoded on a plastic disk (a record) or a magnetic tape. As the turntable stylus (in the case of records) moves back and forth in response to waves in the groove cut into the record, voltages are produced. These are very low voltage signals which are then amplified to the level needed by the speakers. Magnetic tape moves across a playback sensor that also produces low level voltage signals. The record or tape must be played at a specific speed to reproduce the music. If it is played faster, the frequencies of the vibrations are increased and thus the pitches of all of the sounds are raised, in addition to the increase in tempo. Slower playback causes a lowering of the frequencies, lowering of the musical pitches, and decrease in the musical tempo. Variable speed turntables and tape players are critical tools for the round dance teacher, since the music tempo of recorded music is not always at a speed conducive to comfortable dancing. Unfortunately, if the music tempo is changed significantly (more than 5 or 10%) then the musical quality can be significantly degraded. This leads to the Mickey Mouse or Darth Vader effects for vocal music, and a general reduction in the listening pleasure. The term "pitch" can refer to a musical tone or to the speed of musical playback device.

Digital Music. For the purposes of this discussion, the "digital" in digital music only involves a change in the way music is stored (music can be created digitally as well). The voltages represented by wiggles in the groove of a record or changes in the magnetic field of a tape can be represented as a base 2 number stored on some type of medium. Our normal system of numbers is base 10, which means that there are 10 symbols used to represent numerical values. Base 2 uses only 2 symbols, 0 and 1, to represent numbers. Each digit in the number represents a power of two (e.g. 1, 2, 4, 8, etc.). For example, the base 2 number "1011" corresponds to the base 10 number 11 (8 + 0 + 2 + 1). The point is that any number can be represented as a series of 0s and 1s (called bits). A musical performance can be recorded as a

series of voltages produced by a microphone (received from voices and instruments) which are then be converted into 0s and 1s and stored. An advantage of this type of storage, is that the playback is less susceptible (although not immune) to foreign objects on the storage surface and corruption due to damage or transmission of the information. Tape hiss and the pops and clicks from dirty records are absent with digital recordings. One consideration is that enough information must be encoded digitally to capture all the sounds that can be heard by the human ear. This can result in a large amount of data, something like 10 megabytes of data per minute of performance.

Once music (or anything else) is in the digital form, then it can be stored on computer media (CDs, hard disks, floppy disks computer memory) just like other computer files. It can be attached to an email message or put onto a web page. The minidisc is another alternative to storing digital music, which in exchange for its compact size, involves the use of compression methods to reduce the amount of storage space occupied by a piece of music. Devices called mp3 players can store and play files located on a memory stick. With all this versatility in transmitting and storing digital information, the integrity of the information can also be maintained with a high degree of confidence. It is like a word processor file or digital photo: it can be copied, printed, moved around, and sent to your friends. As long as there isn't catastrophic failure of the media, the information in the file remains the same. An additional advantage of digital information is that it can be processed by computer programs. For digital images, computer software exists to extract desired parts, sharpen the image, and add special effects. For digital music, there are programs that allow one to do an amazing variety of things, including the ability to independently change the speed and pitch (musical tones). This is discussed in more detail below. A hybrid digital-analog device is also available. This is a turntable that converts the analog signals to digital ones which can then be processed and/or recorded, converted to analog signals and amplified.

Compare analog and digital music: In the case of analog signals, noise can be picked up and the quality of the signal degraded. For digital signals, in most instances the signals can be transferred noise-free, and the quality of the signal at the receiving end is virtually identical to the signal sent. Often optical fibers or special coaxial cables are used to send digital signals between audio components. There are music aficionados who swear that digital music is of lower quality than a clean vinyl recording. There are also those who prefer amplifiers based on tubes rather than transistors. These are issues the individual must judge for their self. Digital music is so convenient and versatile, though, an exchange of a slight loss of quality is acceptable for most purposes. Figure 1 compares the stages of performance of analog and digital music. In some cases, the arrows represent wires carrying signals from one device to another.

Manipulating Digital Music. There are a number of computer programs (free, shareware, and for-purchase) that can be used to manipulate digital music files. A recent query of the internet revealed literally thousands of programs available for editing, generating, analyzing, and recording digital music. The first step is getting the music into your computer. If your music is on CD, this is easy since virtually all computers have CD players. If the music is in analog format, you will need to connect the music source to the "line in" connector on your sound card. Then you will need some music recording software. We like "Audiograbber"*, but there are many possibilities one can find on the Internet (e.g. Cool Edit, Audio Record Wizard, Super Audio Recorder, 123 Sound Recorder, 1st Sound Recorder, Cakewalk)* that are either free, shareware, or reasonably priced for purchase.

After the music is in a file accessible through your computer, you can manipulate it by selecting a desired section, changing the speed, changing the pitch (musical tone), and adjusting other characteristics (e.g. echo, reverb, pop/click remove, etc.) that we won't discuss here. Among the many software options, our preference is "Amazing Slow Downer"*, but there are a multitude of others (e.g. Goldwave, Cool Edit now called Adobe Audition, Acid Pro)*. With these programs, one can prescribe a change in the speed of the music (percentage increase or decrease) with or without changing the pitch (musical tone), or one can change the pitch without changing the speed, if one desires. You can listen to the adjustments you have made, and if satisfied, save the file to your hard drive or other media. A computer program designed for the Round Dance teacher is DanceMaster* (www.clarkandsandy.com/DanceMaster) that allows one to manipulate sound files, cue sheet card files, set up round dance programs, and keep track of routine play history. The current version of the program allows one to change the speed of the music, and the next version will allow speed changes without changing the pitch.

When working with music, we prefer maintaining stereo format because of the superior sound quality during playback. Many of these computer programs allow manipulation of stereo files (or monaural, if you prefer). These programs are a lot of fun, and allow you to bring quality listening music into the speed range for enjoyable dancing while maintaining the listening enjoyment. Of course, the tempo of music desired for a particular dance routine is determined by the particular style of dance – each has its own recommendations for musical tempo (usually in bars or measures per minute, sometimes in beats per minute) that allow the dancer to interpret the style easily and comfortably. Unfortunately, this metric of music tempo is rarely given (sometimes on ballroom dancing CDs), so to determine it, one either needs to get out their stop watch and count the number of bars that pass per minute, or alternatively, to reference the original speed of the music. Since the manipulation software exclusively determines the speed as a percentage difference relative to the original speed, it makes sense for round dance routines to do the same. We recommend that choreographers on cue sheets give the recommended speed of the music as a percentage change relative to the original (musical tempo can also be given, if you have taken the time to determine it). To get an idea of how these percentages relate to the classic recommended 45 rpm record speed, we have given some examples in Table 1, which shows that a 1 rpm change is equivalent to a 2.2% change in the music speed.

Of course, traditional analog turntables cannot change the music speed without changing the pitch (musical tone). There are modern turntables that can change the music speed without changing the pitch. They are not particularly small and lightweight, so probably not useful for the weekly dance club, but they will allow recording of music from records to mindiscs or CDs at the musical tempo recommended by the choreographer without distorting the musical quality, including direct transfer of the digital signal as described earlier. We like the Stanton ST-100* (about $300; they also have other models), but there are several other manufacturers that make these products (Pioneer, Denon, Gemini, Technics, Numark, etc.)*.

Sources of Music. Clearly vinyl is still a source of music as there continues to be some pressing of records (e.g. Palomino Records, http://www.palominorecords.com), availability of oldie records and through record collectors, but it is becoming rarer and the availability possibly less reliable. CDs represent the current medium of choice for obtaining music. There are a number of ballroom dance labels with very high quality music (e.g. Casa Musica, Casaphon, Ultimate Latin, Ultimate Ballroom, Dancehouse, Dancelife, Andy Fortuna, Tony Evans, Ross Mitchell) in addition to popular labels. Try web sites like Casa Musica (http://www.casa-

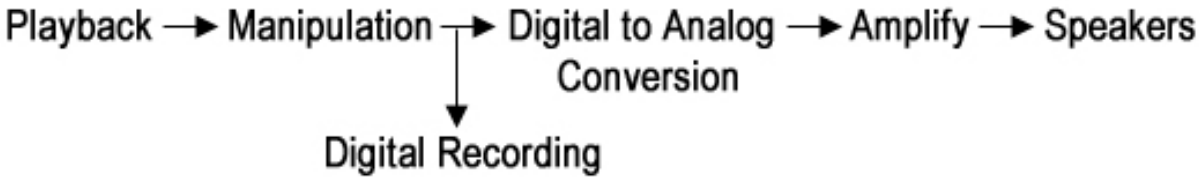
musica.de/asp2/home.asp?sprache=e), www.ballroomdancers.com, and www.dancevision.com. There are a number of old albums that have been remastered and released on CD, and collections of artist's most popular hits that originally released on vinyl that are now available on CD. Online music availability is definitely the most convenient and likely the trend to which all music is moving. There are several sites (e.g. Rhapsody, EMusic, Napster 2.0, i-Tunes, MusicMatch, BuyMusic) that allow you to listen and search through hundreds of thousands of songs, usually for a monthly fee of around $10, and then make CD copies of the songs you want for 79 to 99 cents each. This requires an internet connection and a CD writer at a minimum. Some sites may require minimum versions of some software (for example Windows Media Player or Internet Explorer) usually available for free, and may specify minimum requirements for your computer, but these usually aren't too stringent (in other words, you don't need the latest model computer). These sites do not yet appear to carry many of the ballroom labels mentioned earlier, but often the ballroom CDs contain popular songs that are the same version as on the original artist's CD. Most of these online music sites allow the user to request that the site carry a specific CD label, and the more people who request it, the greater the chance of the online music site carrying it in the future.

Round Dancing is moving away from analog sources of music and toward digital ones. Come along with us as we explore the unique and versatile capabilities of these modern ways of distributing and manipulating music.

**Mention of specific computer programs or audio hardware does not imply endorsement or constitute an advertisement. You must judge for yourself their utility to your applications.*

Analog Recording (turntables, tape players)

Digital Recording (CD, minidisc, mp3)



Digital Turntable

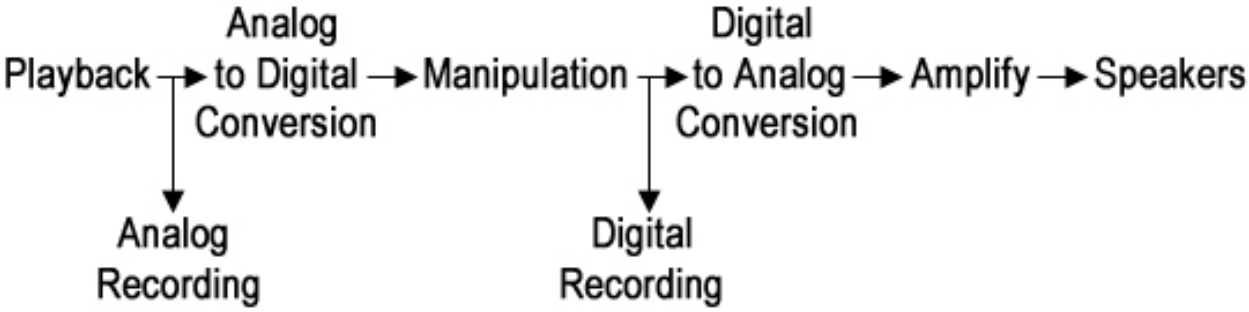


Figure 1.

Speed (rev. per minute)	Relative speed change (percent, %)
40	-11.1%
41	-8.9%
42	-6.7%
43	-4.4%
44	-2.2%
45	0
46	+2.2%
47	+4.4%
48	+6.7%
49	+8.9%
50	+11.1%

Table 1.