

Holophonor: On The Future Technology of Visual Music

Jonathan Weinel, Stuart Cunningham, Richard Picking and Lyall Williams

Glyndŵr University (North Wales, UK)

{j.weinel | s.cunningham | r.picking}@Glyndŵr.ac.uk

Abstract:

This chapter discusses the progression of visual music and related audio-visual artworks through the 20th Century and considers the next steps for this field of research. The principles of visual music are described, with reference to the films of early pioneers such as John Whitney. A further exploration of the wider spectrum of subsequent work in various audio-visual art forms is then given. These include: visualisations, light synthesizers, VJ performances, digital audio-visual artworks, projection mapping artworks and interactive visual music artworks. Through consideration of visual music as a continuum of related work, we are able to consider the 'Holophonor': a fictional audio-visual instrument, as an example of the ideal visual music instrument of the future. We conclude by proposing that a device such as the Holophonor could be constructed in the near-future, by utilising interdisciplinary approaches from the fields of HCI and affective computing.

Keywords:

Altered States of Consciousness, Electroacoustic Music, Electronic Dance Music, Video Games, Visual Music.

Introduction

The Holophonor is a musical instrument of the 31st Century; it is best described as a combination of an Oboe and a Holographic Projector.

The notes played by its user triggers the projector to show holographic images that relate to the mood of the notes. Due to its complicated nature, it requires a great amount of skill to play. According to Leela, only a few people possess the skill to play the instrument - and they are not very good at it.

- Holophonor: Futurama Wiki (n.d.)

The Holophonor is a fictional audio-visual performance instrument, as seen in the science fiction TV show *Futurama* (Groening et al., 2001; Groening et al., 2003), created by Matt Groening. It is an example of the type of new instrument that could result from research or commercial developments in the fields of visual music or interactive audio-visual artworks. In many ways, the Holophonor is the ideal visual music instrument: it operates in real-time, is classically musical, responds expressively to the performer, is portable and creates spectacular, unique visuals that integrate perfectly with the music. As such, the Holophonor provides an excellent lens through which to identify some of the challenges that we might seek to address in order to create the visual music instruments of the future.

This chapter commences with a contextual review of visual music, and the increasingly large sphere of associated audio-visual art, including light synths,

visualisations, light shows, VJ performances, music videos, electroacoustic audio-visual compositions, projection-mapped artworks and real-time audio-visual installations. This provides a necessary background to the field in which inventions like the Holophonor would be situated. The main features of the Holophonor are reviewed, establishing the creative and computing challenges for research in this area.

Visual Music

“There is geometry in the humming of the strings, there is music in the spacing of the spheres.” – Pythagoras (569-475 B.C.)

‘Visual music’ as a 20th Century art form consists of moving visual images or animations, which are organised in a way that the composer considers to be musical. Works may include an original musical soundtrack, or may use an existing piece of music to provide a soundtrack. Others may not use a soundtrack at all, but are considered musical through the structure and arrangement of visual materials. Notable pioneers, as archived by the Centre for Visual Music (2013) include John Whitney, Oskar Fischinger, Jordan Belson, Mary Ellen Bute and Charles Dockum. The work of direct animation (a process where materials are applied directly to film without the use of a camera) film-makers such as Len Lye, Norman McLaren, Harry Smith and Stan Brakhage may also be associated with the visual music label. In a broader context, visual music can be seen as part of the avant-garde artistic practices and experimental film making movements of the early 20th Century (Russett & Starr, 1976).

The origins of visual music date back to the early colour organ inventions (Moritz, 1997) and the paintings of artists such as Kandinsky or Klee, which explore correspondences between music, colours and forms (Collopy, 2000, p.357). While composers have devised various methods to create such correspondences, works are sometimes associated with the phenomenon of synaesthesia: the blurring of senses. For synaesthetes, colours may be perceived to have a sound (and vice versa), smells may be perceived to have a taste, and other sensory correspondences may be experienced. Visual music in essence, realises this phenomena through film, for audiences who do not need to be synaesthetes, and in accordance with the artistic design of a composer (who also may not necessarily be a synaesthete). Perhaps because psychedelic drugs such as LSD heighten the sensory experience and produce synesthetic perception (Julien, 2000, p.347), visual music has also on occasion become associated with psychedelic culture; a link that will become apparent through the course of this chapter.

Visual music compositions usually use abstract (rather than representational) images such as geometric forms and shapes. Compositions such as John Whitney’s *Catalogue* (1961) or *Matrix III* (1972) recall the investigations of the great mathematician Pythagoras, who demonstrated the geometric relationship between harmonic notes in music. For Pythagoras, music expressed the beauty of the underlying mathematical principles of the universe, which could also be experienced through the movement of planets and in other areas of nature. In this sense, music is in essence geometry and movement, and visual music compositions such as Whitney’s are able to explore this through harmony of animated visual forms as well as sound. Visual music as practiced by composers such as Jordan Belson can also be seen as film of the ‘inner eye’ (Wees, 1992). From this point of view, the abstract

visual images are a reflection of the type of internal visual experience that might be perceived in dreams or hallucinations.

While abstract visual imagery and geometric forms are a typical feature of classic visual music, this chapter will adopt a more flexible definition of the term which also encompasses representational visual material. Certainly we may conceive of visual music that includes representational images, Disney's *Fantasia* (Disney et al., 1940) being perhaps the most famous example. While *Fantasia* demonstrates a representational approach, it can certainly be seen as synesthetic, and the fantastical (or nightmarish) content certainly situates it alongside other works of visual music that address internal experience. Of the works of visual music we will discuss in this chapter, *Fantasia* is perhaps the most similar example to the Holophonor.

The Wider Spectrum

Visual music now occupies a space within an area of artworks which includes other audio-visual artworks, such as visualisations, light synthesizers, VJ performances, music videos, video music, 3D projection artworks, hacked and circuit-bent TVs and visual devices, laser shows, light shows and audio-visual (or music themed) video games. The pioneers of visual music can be seen as a vital precursor to some (but not necessarily all) of this work. Over the late 20th Century (post 1980 especially) and beyond, the area has rapidly expanded to encompass a wide range of related practices such as those mentioned. This section discusses key developments in these related areas, and the approaches used. This is necessary to situate visual music in a modern context, and to identify associated technologies or developments that may be of relevance to visual music devices of the future such as the Holophonor. This section does not provide an exhaustive history, but rather a tour of relevant areas with illustrative examples.

Visualisations and Light Synths

Visual synthesizers and associated devices date back to the 1960s and 1970s (Audiovisualizers Inc., 2013). The technology ranges from specialised one-off devices capable of visual synthesis, to mass-produced devices for either professional use (such as visual effects) or home use. For example, in 1976 Atari released the Atari Video Music, an analogue device that could be connected to a home hi-fi system, producing coloured diamond shapes that respond to the amplitude of the audio input (Sonmisonmi, 2007). Devices like this foreshadow subsequent light synthesizers for home computers, such as those Jeff Minter designed for Atari ST and Commodore Amiga computers during the 1980s. Minter also produced the *Virtual Light Machine* (VLM) for the Atari Jaguar video games console (Minter, 1990). More recently Minter's *Neon* provides the light visualizer for the X-box 360 (Minter, 2005). *Neon* is another example of a visualizer that can be used with user-selected music, as commonly found in other media players and games consoles. Minter also produced a feature length visualisation movie *Merak* (Wagner & Minter, 2005) in collaboration with composer Adrian Wagner, which draws upon progressive/psychedelic rock influences and Douglas Trumbull's 'stargate' sequence (Trumbull, 1968) from *2001: A Space Odyssey* (Kubrick, 1968). Of relevance here is also *DeepWave* (Wagner & Carroll, 2001), which explored the generation of visualisations in 3D, utilising analysis of frequency and amplitude of up to 8 audio inputs.

While visualisations have the flexibility to operate with any audio as the source input, Dannenberg (2005, p.28) draws our attention toward the limitations of the approach used. Visualisations usually rely primarily on the use of low-level audio features¹ such as amplitude, which then provide a basis for colourful patterns derived from the waveform. For Dannenberg, this approach is less interesting than those works that find relationships between higher-level features such as musical structure or conceptual meaning. These higher-level features are typically harder to extract; particularly where subjective composition or design is required to form the relationships. Audio feature extraction is likely to remain a useful means to form audio-visual correspondences, and by examining higher-level features we may be able to develop more sophisticated automated or semi-automated visualisations. However following Dannenberg's argument these should probably be incorporated selectively by a composer, or with interactive features as in Minter's light synths.

Liquid Light Shows and VJ Performances

The area of VJ performance arguably grows out of the psychedelic light shows and multimedia performances of the 1960s. During the late 60s and 70s, visual artists such as the Joshua Light Show (Signore, 2007), Mark Boyle and Joan Hills (Robinson, 2007) created 'liquid light shows' for psychedelic rock bands of the time. These shows typically involved live manipulation of oils under projection lamps, and in the case of Boyle and Hills shows with the Soft Machine, chemical reactions. These produced the spontaneously changing and colour projections readily associated with performances of the psychedelic era. As noted previously, the synesthetic properties of hallucinogens such as LSD, which were popular among the counter culture of the time, may have been among the factors that increased the appreciation for these psychedelic light shows for some audiences. Around the same time, Andy Warhol's 'Exploding Plastic Inevitable' multimedia performances with The Velvet Underground and Nico also combined film projection with music and dance.

While many of these performances were transient events, there are clear parallels with visual music films. In particular these practices use materials such as oil, which, as a result of their properties, produce finely detailed variations. Similar aesthetics are found in some of the direct animation films, such as Harry Smith's *Early Abstractions* (1946-57). These 'organic' (as I shall term them) aesthetics, which incorporate natural, micro variation, become less common in audio-visual arts once computer graphics and digital techniques become popular. Efforts have certainly been made to incorporate organic or life-like variations; notably in the evolutionary art of researchers such as William Latham and Karl Sims (Lambert, Latham & Leymarie, 2013), or the work of software artist Scott Draves (2013b). Nonetheless, much of computer graphics through the 1980s and 1990s tended to assume a synthetic aesthetic which remains discernable from 'real-world' forms or 'natural' materials like paint.

Multimedia performances can be seen to continue through the stage and light shows of popular music through the 70s and 80s. In the late 80s and 90s, widespread availability of home computing systems and advances in computer graphics saw an

¹ For a detailed explanation of audio features, see Mitrovic, Zeppelzauer & Breiteneder (2010). 'Low-level' refers to objective measurements such as amplitude, while 'high level' refers to features such as time signature or genre that require interpretation in accordance with a musical or cultural system.

explosion of their presence in audio-visual mediums. Of particular interest for our discussion are the developments around this time that are associated with the rave or electronic dance music scenes of this period. Examples such as Humanoid's *Stakker Humanoid* (McLean, Scott, & Doungans, 1988) music video demonstrate the renewed computer graphics-driven psychedelic visualisations of the acid house scene. The rave movement can be seen as a psychedelic revival of sorts, with 1988 dubbed the 'The Second Summer of Love' (Reynolds, 2008, p.46). In the UK around this time, the drug Ecstasy (MDMA) in particular, and electronic dance music were used as technologies through which young people could experience hedonistic rapture. As the movement spread, 1960s counter culture advocate Timothy Leary resurfaced to proclaim that the computer technology and virtual reality was the medium through which humanity would find evolutionary transcendence (Leary et al., 1994), while Terrance McKenna also spoke as an advocate for the evolution of consciousness through psychedelic drugs and rave music (McKenna & The Shamen, 1992). In this cultural climate, rave parties saw an appetite amongst audiences for immersive laser light shows, computer graphics and 'cyberdelic' symbolism. These are readily captured by popular music videos of the time such as the Prodigy's *One Love* (Howlett & Hyperbolic Systems, 1993), which show regular young men (dance music at this time assumes a similar stance to punk music, where the performers are not presented as particularly separate or other from their audience) experiencing rapturous dance that returns them to notions of tribal unity and spiritual fulfilment; a notion explicitly discussed by McKenna.

Computer graphics at this time can be viewed as the visual counterpart to techno music. Projected at raves, computer graphics enable an additional sensory experience that contributes to the ecstatic sensory overload sought by ravers. Beyond this, the surface aesthetic of the computer graphics (as opposed to the content represented) also becomes a meaningful symbol for the movement. The futuristic look of technology is sought in rave imagery, just as the sound of technology is sought in the aesthetics of techno music (Trowell, 2001). Amidst the rave scene, computer graphics projections were used where possible, and we see examples of VJ mixing: the visual equivalent to a DJ performance, but using visual materials such as short animated 3D loops instead of records. Studio !K7's *X-Mix* series gives an example of 90s VJ mixing and aesthetics (1993-1998), combined with DJ mixes by top house music DJs of the time such as Paul Van Dyk and Laurent Garnier.

Today VJ mixing encompasses a broad range of practices in both live and composed settings. The pioneers of visual music retain some direct relevance for VJ culture; for example, VJ Chaotic (an active VJ and Visual Music composer) cites John Whitney and his book *Digital Harmony: On The Complementarity of Music and Visual Art* (1981) as his main inspiration (K. Scott aka. VJ Chaotic, personal communication July 7, 2013). VJ Chaotic utilises his own bespoke 3D software *Harmony* (Scott, 2013) to create visual music. A wide range of other software is also available and commonly used for VJ performances. The spectrum runs from purpose-built mixing and video loop performance software such as *Resolume* (Koning et al. 2013) and *VDMX* (VIDBOX, 2013), to programming environments like *Max/MSP/Jitter* (Cycling '74, 2013), *Processing* (Reas & Fry, 2001) or *vvvv* (VVVV Group, 2013). Live mixing and real-time manipulation of visuals using a computer is currently more viable than ever before due to increases in the power of portable computers, however in many cases the rendering processes sought have also increased in computational demand. This often necessitates some form of pre-rendering, usually by the

composer, unless royalty-free loops have been purchased, or some other mode of distributed computing is utilised (as in Scott Draves' *Electric Sheep*, 2013a).

While modern works tend to have distinct digital aesthetics, those earlier practices involving oils or direct animation techniques can be incorporated by digitizing the materials or using live camera feeds. For example, at Glyndŵr University digitized direct animation on 8mm film is an approach used by Weinel's visual music composition *Mezcal Animations* (2013). *Mezcal Animations* represents a more traditional approach to visual music, but once works of this type have been digitized, they can be reprocessed and used as source material in other software such as *VDMX*.

Music Videos, Video Music and Electroacoustic Audio-Visual Compositions

Music video, as popularised by MTV during the 1980s presents popular music with an associated video for television audiences. The aesthetic considerations usually differ from those of visual music, since music videos typically represent highly stylised versions of live performances, augmented by camera techniques, lighting, sets, costumes and other theatrical narrative elements. Consequently the majority of music videos have only passing relevance to a discussion of visual music, though some (such as those previously identified) may provide examples of approaches for visual accompaniments to music where representational visual material is sought. In some cases music videos may also assume compositional forms that are also fundamentally similar to visual music. The video for Autechre's *Gantz Graf* (Rutterford & Autechre, 2002) is an example, which uses computer graphics to forge abstract geometry that corresponds with the music. Alex Rutterford, author of the video, cites visual patterns of hallucination seen under LSD as the inspiration for the work, which is designed using a mixture of audio feature extraction and (more predominantly) compositional design (Rutterford & Kilroy, 2002).

Elsewhere, large-scale works of audio-visual film have been devised. Of note is Jochem Paap (known to techno listeners as Speedy J) and Scott Pagano's full-length film *Umfeld* (Paap & Pagano, 2007). Consisting of mostly abstract 3D geometry and digital manipulations of photography (images of industrial surfaces, rust etc.), the piece is presented in 5.1 surround sound.

In the area of electroacoustic audio-visual composition², a range of approaches have been demonstrated by artists using various combinations of film, animation and computer graphics. For example Diego Garro's *Patah* (2010) demonstrates correspondences between visual material and spectromorphology (Smalley, 1986). Weinel's piece, *Tiny Jungle* (2011b) uses altered states of consciousness as a basis for the design of sonic and visual material (Weinel, 2011a). Most fixed electroacoustic audio-visual compositions make use of combinations of digital camera work, 3D, particle effects, visual compositing software or programming environments such as Jitter. Composers such as Diego Garro have found fractal generating software such as *Artmatic* (Wenger, 2012) and *Mandelbulb3D* (Jesse, 2013), a package that enables 3D animated fractals to be produced. Digitizations of analogue material have also yielded impressive results, such as Paul O'Donoghue's *Chasing Waves* (2010),

² Use of the term 'electroacoustic' here refers to 'electroacoustic music': the art music tradition of creating music for loudspeakers using tape, electronic equipment and computers (Manning, 2002). 'Electroacoustic audio-visual composition' is a branch of electroacoustic music which includes a video component.

constructed using analogue hardware at the Experimental Television Centre in New York.

Projection Artworks and Immersive Environments

While projection mapping (or video mapping) dates back to the 1960s (Jones & Sohdi, 2012), it has seen significant growth as an art form over the last decade. This has been used to project on buildings, enabling interesting animations that create illusions of perspective. This method has been used for arts installations, though is most typically used for celebrations, advertisements and other promotional purposes (Roberts, 2012). The illusory quality of projection mapping can be seen as a way in which to induce experiences analogous to hallucination for audiences, who are excited by their disbelief as buildings appear to dissolve, change shape etc. The hallucinatory potential of using digital technology to animate otherwise static objects is more explicitly sought by artists who use projections and LED sculptures as part of the ultraviolet décor for psychedelic trance festivals (3Delica, 2013; Trip Hackers, 2013). These synesthetic artworks can also be considered as a type of visual music.

Stereoscopic 3D has been around for a long time in various forms, but more recently has become commonplace in cinemas and available for living rooms via 3D TV. A few pieces were devised in stereoscopic 3D by the early pioneer (Mortiz, 1999). More recent examples exist, such as Parralaxis work (2010).

Immersive projection can also be achieved using CAVE (Cave Automatic Virtual Environment) or 'Full-Dome' projection environments. These immersive environments facilitate visual projection that surrounds the viewer, usually by either using multiple projectors (CAVE), or by reflecting projections onto contoured surfaces using parabolic mirrors (Full-Dome). Mario Di Maggio's 'Dome Club' in Birmingham uses Full-Dome for experiences that can be viewed as part of visual music culture. For example, the upcoming Dome Club shows combine classic Pink Floyd albums with immersive visualisations (McEuen, 2013).

In our recent work at Glyndŵr University, *Psych Dome* (Weinel et al. 2013) was an interactive visual music artwork that was presented in a Full-Dome. *Psych Dome* used the NeuroSky MindWave: a consumer-grade electroencephalograph (EEG) headset as a control device. Signals from the EEG headset were used to affect various sound and graphical parameters of the artwork. Aesthetically the work was based upon visual music and altered states of consciousness principles.

Laser light shows also deserve a brief mention in this category of other presentation and projection methods. Systems such as Pangolin (2013) enable 3D images and sophisticated compositions reminiscent of John Whitney's work to be created using lasers (LaserimageSweden, 2009). An audio-visual instrument has even been devised using lasers: the *Laser Harp* (Hobley, 2008).

Circuit Bending and Hardware Hacks

'Circuit bending' is the term coined by Reed Ghazala to describe the practice of hardware hacking and modification for the purposes of creating interesting sonic results (Wilson, 2012). The process is often used on devices which are cheaply available, or which may otherwise have become obsolete technology. While circuit bending is most commonly applied to various sound-making devices: children's 'speak and spell' toys, keyboards etc., there are also examples where these practices extend to the visual domain. For example, James Connolly and Kyle Evans' 'Cracked

Ray Tube' projects modify TV screens to produce interesting visual patterns with associated sounds (Connolly & Evans, 2013). Karl Klomp (2011) also modifies hardware such as video mixers in order to produce interesting visual results. Some examples such as these are able to use sound as an input to affect the visual results, and therefore could be considered as a form of 'glitch' (Cascone, 2002) visual music.

Music Video Games

Music-based video games have existed as a niche market for some time. The popularity of *PaRappa the Rapper* (NanaOn-Sha, 1996) on the PlayStation during the mid 1990s substantially boosted the market, with various other audio-based games following in its success. Around this time, some titles exploited the connection between video games and rave culture, a connection that Sony actively supported at points through their marketing approach toward young adults (Poole, 2004, p.7). This strategy even included creating a promotional lounge at the Ministry of Sound nightclub in London (Kushner, 2012, p.28). This link was manifested in various PlayStation titles; through the techno soundtracks of games like *Wipeout* (Psygnosis, 1995), music-making titles like *Music 2000* (Jester Interactive, 1999), or *Fluid* (Opus, 1998): an ambient techno orientated game where the player controls a dolphin and creates remixes. It was also reciprocated, as rave audiences adopted the Playstation as a post-clubbing device, and dance producers sometimes sampled the games in their music (Reynolds, 2008, p.124).

While explicitly rave-orientated titles were (and remain) a niche in video games, the connection was also seen in a minority of subsequent titles on various systems, such as *Rez* (United Game Artists, 2001) and more recently its prequel *Child of Eden* (Q Entertainment, 2011). These are essentially action games that involve shooting enemies, however they utilise a musical twist in that the player's weapon is synchronised with the music, and triggers musical sounds (such as drum or keyboard 'hits'). Aesthetically the titles exploit the association between rave culture and futuristic computer graphics impressions discussed previously. In doing so, the visual material falls somewhere between representations of futuristic machines, luminescent organic life forms (evoking the ultraviolet decor of psychedelic trance festivals) and abstract geometry that recalls visual music pioneers such as John Whitney. The music consists of electronic dance and trance music by established producers. Since musical control is limited the games do not particularly satisfy a description of 'audio-visual instruments', but do show a possible method of integrating music with representational and abstract visual material. Critically as video games they are also real-time, so it is possible for us to conceive of games such as these being adapted to provide increased musical or visual control for the player.

In the past decade *Guitar Hero* (Harmonix, 2005) is notable as one of the most commercially successful audio-game titles. *Guitar Hero* follows a familiar system used by many other music-related video games, where the player must complete a pattern in synchronisation with the music. Though there are obvious parallels with the performance of scored music, these type of games are of less interest to my discussion than those that enable a greater level of creative control. *Guitar Hero* offers very limited scope for individual choice concerning the timing or arrangement of notes: the game rewards machine-like precision, and punishes improvisation or other deviation from the 'score'.

Of more interest to my discussion are those titles such as *Electroplankton* (2006), *Thicket* (Interval Studios, 2010) or the forthcoming *SoundSelf* (Arnott, 2013), which enable greater levels of creative choice from the player to construct audio-visual experiences. These titles give the player open control over the audio-visual experience, albeit mediated by the design of the software. In this sense they are fundamentally similar to computer-based audio-visual musical instruments. *SoundSelf* generates visualisations from the player's voice, the sound of which is also augmented using digital signal processing. This premise is technically similar to other interactive visualisations discussed, however, seen in the recent resurgence of indie gaming (the project is independent and crowd-funded), titles such as this could pave the way for further audio-visual games or instruments for a wider audience.

Real-time Visual Music Performances

Lastly, we may also consider the real-time visual music performances that are presented in concerts and events such as *Seeing Sound* (Bath Spa University, 2013). *Seeing Sound* is a biannual conference on visual music, which in 2013 focused on real-time visual music performance, and included a programme of real-time concerts alongside screenings of new and classic works of fixed-media visual music. Amongst the real-time performances: Ryo Ikeshiro's *Construction in Kneading*, a live audiovisualisation based on Mandelbox fractal (Ikeshiro, 2013); Max Hattler and Matthias Kispert's *Feeding You*, a neo-psychedelic anti-retail piece which visually and sonically warps a variety of corporate brandings (Hattler & Kispert, 2013) and *Hidden Fields / Danceroom Spectroscopy*, a live performance that combines real-time visual music with dance, using methods from computational physics as a design principle for the visuals (Glowacki et al., 2013).

Discussion

As with much of art and music in general in the late 20th Century and early 21st Century, we have seen a significant expansion and diversification of practices broadly related to visual music and audio-visual art. Several emergent areas of visual music culture have been identified, and from these examples have been provided, and approaches discussed. Across these we find many different methods for creating synesthetic combinations and audio and visual material, with valuable contributions from both academic research and work in the popular sphere. Almost all these works rely on some form of projection. The examples given emerge from different areas of culture, but under a less ridged definition of the 'visual music' term, can be seen as part of a visual music continuum. The general trend of this continuum seems to point towards interactive audio-visual artworks, with computer audio and graphics.

Holophonor

We may argue that the Holophonor is in many ways the ideal visual music instrument. In a single, portable instrument it offers many of the features that visual music performers seem to strive for. It is highly expressive and adaptable, providing audio-visual material that is perfectly integrated, synesthetic and immersive. Performed materials respond closely to the emotions of the performer. While some learning is required, virtuoso performances of a high artistic quality are possible. The Holophonor may therefore be a useful example, in considering the challenges and next steps when designing the visual music instruments of the future.

Among the visual music examples discussed in this chapter, many demonstrate individual features or capabilities that would make up a Holophonor-like device, but none combine all of these features in a single, portable and expressive device. The sounds of the Holophonor can be achieved using established approaches of musical composition and performance. Visual material of the type should can be mixed and combined with sound using existing technology. While holographic projection as shown in *Futurama* may not yet be possible, highly immersive projection can be achieved using high-definition screens or domes (for example). The ability of the Holophonor to respond to the emotions of the user could be facilitated through the use of biofeedback technologies and approaches from affective computing (Picard, 2000). Computing technologies are now also small and powerful enough to facilitate the digital requirements of a Holophonor-like device in a portable package.

Perhaps the main challenge for visual music research then, is to converge existing technologies into a single, portable package that anyone can pick up, learn and play. Music video games offer this level of accessibility, but do not seem to facilitate truly original or adaptable performances of a high artistic quality. Conversely, many of the real-time visual music examples discussed demonstrate high artistic quality, yet lack accessibility for a general audience. Many of the current performers are experts in artistic and computer programming fields (or comprise teams of experts); this seems to be a necessity for realising interactive visual music performances of high technical and artistic quality. Yet this level of required expertise reduces the potential for most regular people to enjoy actually playing and performing visual music. Arguably this also shifts the emphasis away from performing with an instrument, and on to building and designing it. What the Holophonor seems to offer that current systems do not, is an ‘off-the-shelf’ convenience; one could walk into a shop, try out and buy a Holophonor, just as one might do with a guitar or trumpet. As Fischman discusses then (2011), it is this accessibility coupled with the potential for adaptability and virtuoso performance that is one of the main challenges for research in this field.

Conclusion

Through the course of this chapter we have discussed visual music and the wider spectrum of associated audio-visual artistic practices and technologies. It should be apparent that there are clear links and parallels between these different areas, and that work in this area should be informed by the knowledge and practices that have emerged from both academic and popular spheres. The continuum of visual music as discussed here undoubtedly points towards real-time performance instruments. Yet current examples do not provide the convenience and accessibility of traditional acoustic musical instruments. In this context the Holophonor is useful as a fictional representation of a kind of ideal visual music instrument, and enables us to recognise some of the challenges which research in this area might seek to address. While most of the key features of the Holophonor can be found in the various examples given, we do not find them all in one place. Hence it seems that a convergence of approaches is needed, combined with research that addresses issues of accessibility. We may then be able to provide the visual music instruments of the future, which enable anyone (even Fry) to create and enjoy the ‘music of the spheres’, not just specialists.

Key Terms and Definitions

Acid House

A type of electronic dance music originating in Chicago during the 1980s, which typically features basslines constructed with the Roland TB-303 synthesizer.

Affective Computing

Describes computer systems which recognise or exhibit properties of human emotion.

CAVE

A CAVE (Cave Automatic Virtual Environment) is a virtual reality environment in which immersion is enhanced through projection on multiple walls, often in combination with stereoscopic technology.

Electroacoustic Audio-Visual Composition

A variation of electroacoustic music that combines electroacoustic music with video.

Electroacoustic Music

A type of 20th Century art music composed for concerts utilising loudspeakers.

Holophonor

A fictional audio-visual instrument from the TV show *Futurama*. The instrument is similar to an oboe, and projects holographic visual images that correspond to the musical performance when played.

Projection Mapping

A method of projection in which projected images are 'mapped' on to irregularly shaped objects such as buildings in order to manipulate their appearance.

Spectromorphology

An approach to sound materials and musical structure established by Denis Smalley, which focuses on the spectrum of available pitches and their shaping in time.

Visual Music

A type of artistic practice that involves the arrangement of visual material into music-like structures.

VJ Performance

A type of multimedia performance usually found in nightclubs, in which a VJ (visual jockey) combines video loops or computer graphics to accompany music.

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