Handheld Console Comparisons: Lateral Consumer Machines as Musical Instruments

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This topic will examine the field of modern chipmusic – being the composition and performance of present-day electronic music on obsolete videogame hardware. Recent software utilities neither authorised nor endorsed by first or third party corporations are used.

In particular, the topic of specific differences between hardware units and models in relation to the genre of Game Boy music will be explored.

Unlike devices that are designed and manufactured for the explicit purpose of producing and composing music (relevant examples include palm studios, handheld recorders and portable synthesizers), Gameboys were originally created first and foremost as toys. In the context of music making, the Game Boy can be considered a lateral device – a machine that has been taken out of its original context and now serves a new and different purpose.

By extension, it can be assumed that the design and production quality of such a lateral device for the use of music would be lower than that of a machine designed from the ground up and exclusively for such a purpose. It is a matter of what the first-party corporation deems as vital for the end-user demographic. A portable video game console manufacturer will have certain priorities – in particular, cost effectiveness relating to production, ease of use and accessibility, battery life, visual appearance, physical bulk and so on. The retail price of a unit for the end-user must be very competitive.

Such was the case when the original Game Boy was introduced in 1989. The machine was a direct competitor to the Atari Lynx. The Lynx boasted advanced technical features for the time, including a backlit colour liquid crystal display, 8 bit sound delivered across 4 channels and the possibility of relatively large-scale networks of up to 18 machines. Nonetheless, with an initial retail price of US$179 (double what Nintendo was asking for the Game Boy upon release), the Lynx was a failure. [1]

The purpose of this paper is to provide a starting point reference to the differences in sound between the various models of Gameboys capable of playing original software titles. The differences in sound between different units of the same model will also be discussed in addition to anomalies between models and issues of quality across a given model line. Some regard will be given to serial numbers; however, there are too little subjects in order for the chronology of production versus sound quality to be of any real significance.

For individuals wishing to take part in the Game Boy music community, the question arises as to the Game Boy model they should purchase, with which to compose and perform. Although often asked, the question 'Which Game Boy sounds the best?' is not an irrelevant one, considering there are at least (depending on definition) six different models released between 1989 and 2003 that share the same software library. This longevity in succession is testament to the Gameboy's commercial achievement and popularity. [2]

Although some research has already been done in this area the aim of this paper is not to supercede or infringe on the available work. Rather, it has been written with the aim of adding to what already exists. The results of the comparisons presented here are available online in an accessible and easy to read format. Downloadable sounds that serve as an aural comparison for the end-user as well as sonograms and waveform representations are also included. At the time of writing, the online Game Boy comparison is located at: http://www.milkcrate.com.au/_other/gbc/.

An example of research that has already been done in the area of Game Boy sound comparisons comes from Herbert Weixelbaum, a well known Austrian Game Boy musician and founder of the Vienna Game Boy Music Club. Weixelbaum has created an excellent online resource detailing sound comparisons between various models of Gameboy. He covers visual pulse waveform analysis and describes the types of noise and timbre generated by each of the Game Boy models he has compared, allowing the user to listen to the differences. At the time of writing, Weixelbaum's online Game Boy comparison is located at: http://www.herbertweixelbaum.com/comparison.htm [3].

This paper will cover the commonly available models of Game Boy that are able to play original Game Boy titles (as opposed to Game Boy Advance software). This includes the original Gameboy, Game Boy Pocket, Game Boy Color, Game Boy Advance and Game Boy Advance SP. A total of 34 individual units across these five model lines have been recorded and the results analysed and compared.

The original grey Gameby was released in 1989 and features a relatively large, green and black display. Its successor, the Game Boy pocket, features a smaller form factor with a clearer display and uses two AAA batteries as opposed to four AA. As a result, battery life was roughly halved when compared to the original.

In 1996, Nintendo released the Game Boy color. This machine represented a large step forward for the Game Boy family as it was able to display 56 different colours on screen of a possible palette of 32,768.

2001 saw the release of a 32-bit portable gaming platform, the Game Boy Advance. The model is completely backwards compatible with original Game Boy and Game Boy Color software. This compatibility is achieved without software-based emulation.

The Game Boy Advance was followed up in 2003 by the Game Boy Advance SP with a backlit display and a more compact (and different) form.

Due to financial and time constraints, the Game Boy Light and Game Boy Advance SP 2 are not represented in this investigation at this point in time. However, both of these are included in Weixelbaum's overview of Game Boy sound comparison, should a comparison with these units be desired. It also should be noted that research such as this is still very much a work in progress and will hopefully be complemented with the addition of these models in the future.

For the sake of coherence and simplicity non-portable devices that potentially are able to play original Game Boy titles have been ignored in this paper. This includes the Super Game Boy and Super Game Boy 2 as well as the Game Boy Player. These devices are peripherals for the Super Nintendo Entertainment System and Nintendo Gamecube respectively, and use a television for visual display. Other members of or successors to the Game Boy line that are unable to play original software without software-based emulation have also not been incorporated. This includes the Game Boy Micro, the Nintendo DS and the Nintendo DS Lite. For the sake of completeness, all of these machines have been included in the online Game Boy sound comparison reference.

The Game Boy does not have an individual sound chip as such. Instead, the main processor handles sound routines, including sound output. The pseudo audio processing unit of a Game Boy has a total of four channels. Channels 1 and 2 are pulse wave oscillators. Channel 3 is a programmable waveform channel capable of playing back samples and synthesizing more complex waveforms. The last channel is a noise channel. [4]

Methodology for testing the sound characteristics of each unit has been undertaken by programming a simple test song and playing this song back on the different Gameboys. The same gain setting has been used on the recording hardware and software and the same cables and connectors have been used to connect the Game Boy to the audio recording chain. After having been recorded, none of the samples have been normalized. All units are powered using batteries of various types during the recording stage, so as to minimize noise and interference generated by use of a mains power transformer.

The test song has been written in Little Sound DJ (commonly abbreviated to LSDJ). This is a popular Game Boy music tracking program written by Johan Kotlinksi. The author himself describes it as "…The Game Boy… tool of choice for amateur & professional musicians and composers!".

This test song trials each of the four sound channels. The two pulse channels are tested across the four types of waveform that they are able to reproduce – these being approximate square waveforms with duty cycles of 12.5%, 25%, 50% and 75%. These waveforms are played back using notes whose pitches are spaced a perfect fifth followed by a perfect fourth. This process starts at the C two octaves below middle C and continues for a range of six octaves.

This procedure is followed by a set of broken chords and arpeggios played very quickly interspersed with frequency sweeps by pulse channel 1 and portamento by pulse channel 2.

Channel three is tested next, with basic playback of a set of samples from a drum kit. The same series of samples is then played on a loop whose length is continuously getting shorter. Rudimentary pitch-shifting is also employed.

The test concludes with a collection of short bursts of noise that have been shaped by using different cut off frequencies of a low pass filter.

It should be obvious that the test song does not in the least exhaust the capabilities of the Game Boy in terms of its possible diversity of sound output. This is not the aim of the test song. Rather, the point is to play back test material through which one is able to quickly and efficiently form an overview of the sonic characteristics and performance of a given unit.

One issue when considering the sound quality of a device is the type and amount of self-noise that it creates even when it is not playing any music. When using Gameboysare used as musical instruments, background noise can be split into two broad categories – relatively broadband noise, whose components are not harmonically related; and noise whose components are harmonically related but not affected by which particular notes a unit might be playing at a given moment. This latter type of non-musical harmonic noise is responsible for a buzz or a hum type sound present in the signal even if a sequencer is stopped. It can be considered an annoyance to the average Game Boy musician.

The issue of non-musical harmonic noise is an interesting one in respect to all of the Game Boy models. As a general observation, this harmonic noise is most prevalent when the sound output drops out as a result of apparent hardware or software failure.

An appropriate starting point for discussion regarding this harmonic noise is the result of a sonogram of a certain purple Game Boy Color. Unfortunately, this particular Game Boy Color was purchased second hand for this investigation and as a result lacks a serial number. Thus, it cannot be placed in a chronological timeline in reference to the other Game Boy Colors whose sonic characteristics have been recorded.

The pseudo audio processing unit of the purple Game Boy Color appears to fail when the frequency sweeps oscillate back and forth by extreme amounts. No musical sound is emitted from the unit in these short periods. However, it is at these positions that the sonogram shows a large band of non-harmonic noise in the mid to upper frequency range as well as an obvious harmonic series (see figure 1). In the sonogram, the vertical axis is frequency and the horizontal axis is time.

In figure 1, the sonogram of an artificially synthesized harmonic series beginning with 766Hz can be visually compared with the noise recorded at the moments of audio playback failure of the anomalous purple Game Boy Color. The most striking feature is the dominance of even harmonics within this noise (with the exception of the 2nd and 14th) compared to their odd-numbered counterparts. The 12th, 22nd and 24th harmonics are particularly prominent. In addition, the odd- numbered harmonics appear to consist of broader range noise rather than very tightly confined notches in the spectrum. Nonetheless, they are still strikingly visible in this representation.

Certain harmonics of this series are found (of course with varying amplitudes) across the board in almost all of the units and models of Gameboys that have been investigated in the course of this research.

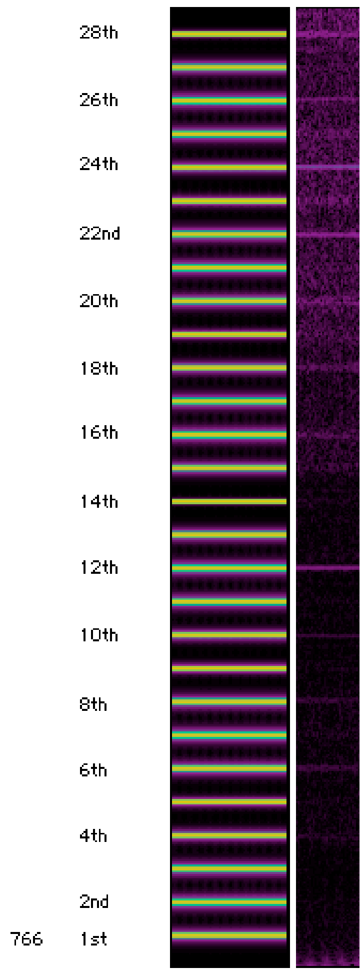

Figure 1: A comparison of a harmonic series with a 1st harmonic of 766Hz compared to the anomalous Game Boy Color's noise.

The original Game Boy units appear to be the least susceptible to this harmonic noise. The sonogram of a typical unit is shown in Figure 2. The original Game Boy model tends to pronounce the 12th harmonic the most, followed by a weaker 24th. This 24th harmonic only clearly appears on the oldest unit that has been recorded. This unit also has manifestations of noise around the 8th and 16th harmonics points.

An interesting point of note is the results from a sonogram of the single modified original Game Boy that is included in this investigation. With this particular Gameboy, the crystal resonator has been replaced with a new one operating at roughly half the speed. This results in a unit whose pitch is significantly lower and whose playback speed is significantly slower than an unmodified unit. There are no visible or audible harmonic noise bands of the same type as can be seen and heard with the other original Game Boy units. However, it is possible that this is simply a coincidence and not a result of the modification. .

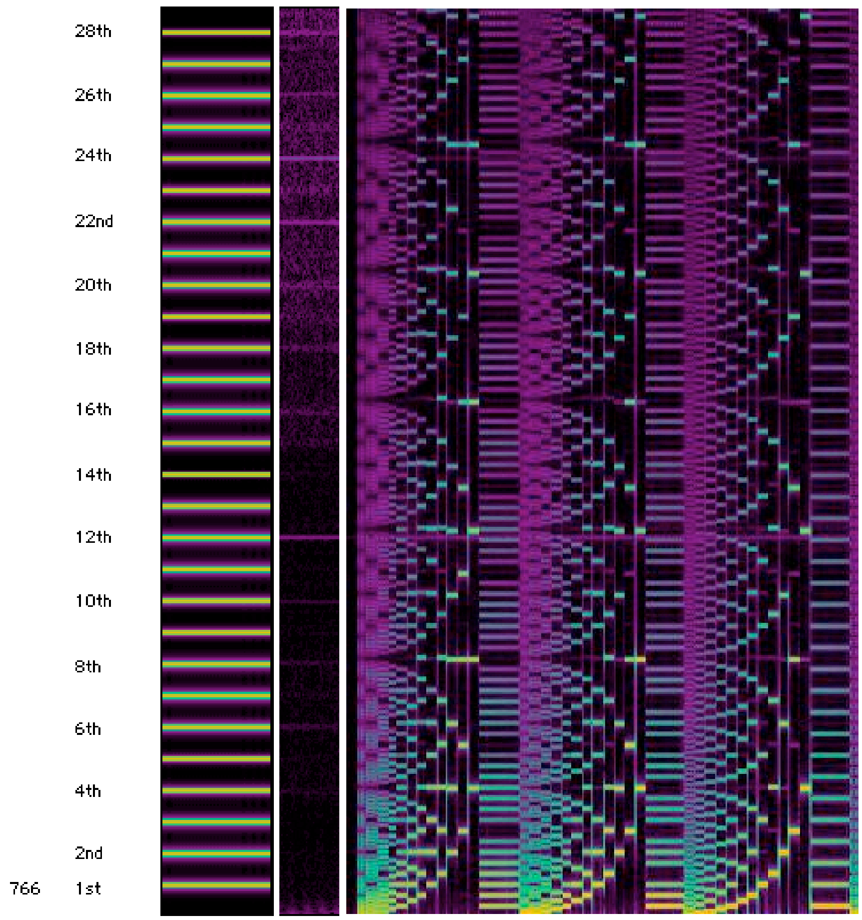

Figure 2: A typical sonogram of an original Game Boy unit (to the right).

The Game Boy Pocket units hardly vary at all in their harmonic noise content. All units tested displayed a relatively prominent 12th and weaker 24th harmonic. An interesting side note is that the band of noise around the 12th harmonic is significantly broader than any other model at that harmonic. This fact is demonstrated in all eleven Game Boy pocket units tested. The Game Boy Pocket represents the least amount of difference in background noise and changes timbre and output volume upon comparison on a unit-by-unit basis.

The last of the classic models– the Game Boy Color – tends to exhibit harmonic noise at the 12th, 18th and 24th harmonics. The 12th harmonic is always present at roughly the same amplitude, regardless of whether the unit is outputting sound or not. This is in contrast to the 18th and 24th harmonics, which are much higher in amplitude if the unit is actually playing back music. There is a larger difference in maximum playback level and amounts of overall broadband background noise in the Game Boy Color model on a unit-by-unit basis when compared to any other model of classic Gameboy.

The Game Boy Advance possesses a similar harmonic noise profile to a relatively clean-sounding Game Boy Color. This is in contrast to the Game Boy Advance SP. In this case, all harmonic noise relates to a series whose fundamental is approximately a perfect fourth above the harmonic noise series seen on all of the classic models.

There are many other issues to consider when comparing various Game Boy models, some of which can be found in the online reference. Nonetheless, background noise is an important issue and impacts, for instance, upon a Game Boy unit and model's suitability for live performance.

Having been invented and implemented originally as toys, one manifestation of which are differences in sonic characteristics, the choice of which Game Boy model is the most appropriate for composition and performance is important.

In closing, it should be iterated that this investigation is one that will never be completely finished, as such. It should simply be viewed as being a reference or a growing guide for the Game Boy music community from which hopefully something may be learned.

References

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