John Cage: Crafting Randomness

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Abstract

John Cage's understanding of randomness, and his use of it, was far more sophisticated than many people think. Whether working with the *Music for Piano* series in the mid-1950s, or in constructing the electronic music construction kit that is *Cartridge Music,* or in the design of the IC program (co-written with Andrew Culver) in the 1980s, or in the use of the *Mesostic* process in the *Writings Through Finnegans Wake* (and others), there are very clever uses of process at work. In the *Music for Piano* series, three timbral possibilities are set up, and the 64 possible numbers given by the I Ching are divided up in a very uneven way, such that one of the timbres hardly appears at all. In *Cartridge Music,* the choice of gestures that the results of the process are applied to creates a unity among different versions of the piece, such that one can clearly talk about *Cartridge Music* as a unique compositional entity. In the IC program, which became the basis for much of Cage's composing in his last decade, there are options for generating random numbers with unpredictable, yet skewed probability distributions. These distributions can also change at unpredictable times, if desired. The *Mesostic* process extracts a new text from pre-existing ones. The restrictive rules of the process guarantee a certain kind of "rhythm of extraction" from the target text. For example, if one uses 'The Garden of Evening Mists' as the "mesostic spine", at a certain point, one has to find a word with "V" in it ("Evening"), but that word cannot have an "E" following the "V". There are very few English words having a V that do not have an "E" following the "V". (Vary, vagary, vigour would all be possible, for example.) So at this point, in extracting the poem from the target text, one has to search for quite a long time to find the proper word. The use of this particular "spine" guarantees that large portions of the target text will be skipped over in the extraction process, and shortens the length of the potential text. By understanding these processes, and the way they are carefully constructed, one can get a glimpse into the very crafty, and crafts-manly compositional mind of John Cage.

Keywords John Cage, compositional techniques, randomness, algorithmic processes, *Music for Piano*, *Cartridge Music*, *Writing Through Finnegans Wake*, *IC* program, *I Ching*

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I've been working with random processes since the late 1960s. I've investigated many different kinds of random and found-object processes, from simple random numbers to probability distributions to chaos equations to cellular-automata systems to transcriptions of, and interactions with, natural processes. In all of those investigations, I've learned that there are many different varieties of "random," each with their own flavour. Some, like equal-weighted random numbers, produce results which correspond to the traditional notion of "random" – over the long term no repetition can be perceived. Others, like some chaos equations, produce results that are unpredictable in the short term, but which (with the same variables) always repeat exactly, and always within the same "field" of events.

Some, such as a specifiable probability distribution which can have unpredictable results, but always with the same few elements. For example, if the randomness is applied to pitch, this can result in a traditional chord being arpeggiated, but in a random order. One will always have the same chord playing, but always in a different order.

Over this same period, I've performed a number of John Cage pieces, and what I've seen there is that for every piece, John Cage created a different process, to produce different "random" results. In fact, for some of the pieces in the 50s, such as the *Music for Piano* series, where Cage used the location of imperfections on paper to determine where musical events would be placed, the results are not so much "random" as they are "unpredictable." That is, if one were to statistically analyse the events produced by the imperfections, one would almost certainly not find an absolutely even distribution of events – one would find a very unusual distribution of events – one that reflected the structure of the particular piece of paper being used. (I leave it to those of you of a more empiricist frame of mind to actually analyse the paper in question to see if this is the case. My intuition tells me with an extremely high degree of certainty that the results of analysing paper imperfections compared with equal-weighted probability will almost certainly reveal that the paper imperfections do not correspond to equal-weighted probability. This is an intuition I'm happy to accept until proven otherwise.)

Specific Processes

Over the course of his career, Cage explored many different kinds of unpredictable systems. Random numbers with an equal weighting (such as those sometimes produced by the I Ching oracle) were only one of his interests. In fact, from the very beginning, his use of random resources was as unusual as the kinds of randomness he explored. For example, the use of the I Ching to produce numbers from 1-64 (if one doesn't take the changing lines into account) produces numbers which are pretty close to equally weighted random, but in the *Music of Changes,* his first "random number" work, he doesn't use the numbers to select from a list of pitches, but rather, to select from pre-composed elements on a chart. The sounding surface the listener hears is the result not just of simple random selection, but of random selection of a controlled group of elements.

Years later, in the 1980s, when Cage and Andrew Culver created their "IC" computer program, they built into it a number of kinds of randomness which continued the practices Cage was already using. More on this later.

In his works of the late 1950s and early 1960s, Cage created a series of works, mostly for live-electronic performance, for David Tudor and himself to play, in which "indeterminacy" was explored. In works like the *Variations* series and *Cartridge Music*, templates were created, usually on clear plastic, which were juxtaposed to create a wide variety of results. However, in the case of *Cartridge Music*, Cage specified what the results of the superimposed templates were to be applied to. While keeping the results as open as possible, Cage specifies the instrument (found objects amplified with phonograph cartridges) and the kinds of gestures to be performed on them (principally loops). The phonograph cartridges have a distinctive frequency response – a kind of "sound." So whenever I hear a Cage piece with scrappy percussive type sounds with a narrow frequency range, and those sounds are played in loops, I'm pretty sure I'm hearing a version of *Cartridge Music.* Even if the moment to moment details are different in every case, that overarching kind of sound is so distinctive (there are other features of a *Cartridge Music* realisation – silences, occasional feedback, single, striking attacks), that the identity of the piece is ensured. Eventually, Cage would create a piece or two which could sound like ANYTHING (*0'00"* is one of these), but for the vast majority of his pieces, even the indeterminate ones, he is always careful in specifying the field to which unpredictable results are applied.

An excellent discussion of realising *Variations I* and *Variations II* is found in David Miller's paper, "The Shapes of Indeterminacy: John Cage's Variations I and Variations II," in which he points out that by following the processes specified by *Variations II*, one always arrives at uneven distributions of elements, and each realisation of the score produces a different uneven distribution. This is quite precisely what interested Cage – not simply randomly distributed elements, but a constant sense of different kinds of surprises, and different frequencies of occurrence for each kind of surprise. (Also worth consulting is Marc G Jensen's *John Cage, Chance Operations, and the Chaos Game: Cage and the 'I Ching'* in which he points out that the use of the I Ching generates results which are non-linear, and quite different from those produced by chaos equations of various kinds.)

The IC Program

In the mid-1980s, Cage and Culver created the IC program to generate numbers to be used in their work. IC was just one of a number of programs they created. (A full listing of the programs can be found at http://www.anarchicharmony.org/People/Culver/CagePrograms.html) In 2010, I had just completed work for Algorithmic Arts and John Dunn, for the algorithmic composing program *ArtWonk*, creating packages of different kinds of random functions – a group of 17 different random probability functions, a similar number of fractal functions (in addition to the 14 fractals built into the program), a series of 13 different chaos equations based on Julien Sprott's work, and 11 different additive-sequence generators inspired by speculative music theorist Ervin Wilson's work. Having made all of these composing resources, I was curious about what Cage and Culver had actually done with their IC program. (Which, by the way, is now available as an on-line app, so that one can generate results endlessly with it. The app is at http://www.anarchicharmony.org/IChing/ic.cfm. This replaces

the original command-line DOS program which could only operate on PCs.)

In the program, there are a number of options for the kind of numbers you can generate, called bias, immobile bias, non-repeating, and no bias. No bias is the norm – if nothing is specified, that's what you get – an equally weighted set of random numbers. Bias is selected with a –b, immobile with –i, and non-repeating with –nr.

For example, in the old DOS version, this command generates 1000 numbers between 1 and 12 with immobile bias:

ic 1000 1 12 -i

I wondered about these options – 'what were they?' To find out, I generated 1000 numbers between 1 and 12 with the same parameters, only differing with bias, immobile or no bias. Here are the commands used:

For bias numbers: ic 1000 1 12 -b

For immobile bias numbers: ic 1000 1 12 -i

For no bias numbers: ic 1000 1 12

I saved the output of these runs as text files, which I loaded into the *DataBin* sub-program of *ArtWonk*, saving them as array files that *ArtWonk* could understand. *ArtWonk* then displayed the results as shown below:
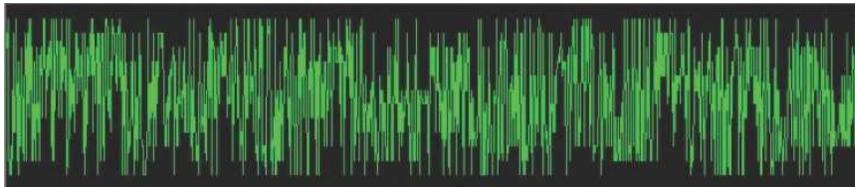

Figure 1 Graphic Display of distributions generated by the different options in the
Cage-Culver IC program.

I think one can see what's going on from the pictures. In Bias, certain values are favoured, creating an uneven probability distribution, but which values are favoured constantly changes. Note how there seem to be "blocks" or "clumps" of values which then change level to other "blocks" or "clumps". For Immobile, one uneven probability distribution is chosen, and then kept for the whole of the program's run. Note in that picture how the clumping's are very even, and don't change over the course of the picture. For No Bias, the results look more like random noise – even the areas where a particular value disappears or is favoured are very brief and are in line with what one would expect from something approaching equal-weighted random numbers.

Using an *ArtWonk* patch (shown below), I generated some piano (or other instrument) music using each distribution in turn. Pitch is the parameter the numbers are mapped to. Longer examples might be helpful, but even with two lines of each distribution, the differences between the kinds of distributions are immediately heard. Bias has more grouping of the values into "modal" formations, which quickly change to other modal formations, Immobile has a real feel of there being a "harmonic field" and that "harmonic field" sound is unchanging. No Bias sounds like an equally weighted distribution   of   the   12   pitches,   at   least   to   my   ear.

Figure 2 Musical Output of IC results from above

Figure 3 Art Wonk patch used to generate musical results above.

A better picture of what "Immobile Bias" is might be shown by the following number sequences. These are three different runs of the immobile bias program, generating numbers from 1 to 12, and then sorted in ascending order. By sorting the numbers in ascending order, one can see the kind of uneven probability distribution produced by the program on each run. Notice for example, in example 2 how the number 5 does not occur, and the predominance of 5 and 10 in example 3.

Example 1:
ic 100 numbers between 1 and 12
with immobile bias, sorted ascending

```
 1  1  1  1    1  1  1  1    1  1  1  1    2  2  2  4
 4  4  5  5    5  5  5  5    5  5  5  5    5  5  6  6
 6  6  6  6    6  6  6  6    6  6  6  6    6  6  8  8
 8  8  8  8    8  8  8  8    8  8  8  8    8  8  8  9
 9  9  9  9    9  9  9  9    9  9  9  9   11 11 11 11
11 11 11 12   12 12 12 12   12 12 12 12   12 12 12 12
12 12 12 12
```

Example 2:
ic 100 numbers between 1 and 12
with immobile bias, sorted ascending

```
 1  1  1  1    1  1  1  1    2  2  2  2    2  2  2  2
 2  2  2  2    2  2  2  2    2  2  2  2    2  2  2  2
 2  2  2  3    3  3  3  3    3  4  4  4    4  4  4  4
 4  4  4  6    6  6  6  6    6  6  6  7    7  7  7  7
 7  7  7  7    7  7  7  7    7  7  7  7    7  7  7  7
 7  8  8  8    8  8  8  8    9  9  9 10   10 10 12 12
12 12 12 12
```

Example 3:
ic 100 numbers between 1 and 12
with immobile bias, sorted ascending

```
 1  1  1  3    3  3  3  3    3  3  5  5    5  5  5  5
 5  5  5  5    5  5  5  5    5  5  5  5    5  5  5  5
 5  5  5  5    5  5  5  6    6  7  7  7    7  7  9  9
 9  9  9  9   10 10 10 10   10 10 10 10   10 10 10 10
10 10 10 10   10 10 10 10   10 10 10 11   11 11 11 11
11 11 11 11   11 11 12 12   12 12 12 12   12 12 12 12
12 12 12 12
```

In a recent piece, *John's Echoes (2014)* I generated ten 100-element immobile-bias sequences with IC, and used these to control pitch, duration, and loudness of individual

notes of a musical sequence. I created an interface that would allow me to select any of the 10 options for each parameter before starting the sequence playing. This gives me 1000 possible versions of the piece (not to mention that there are 8 possible tempi for each run of the piece!). A typical live performance consists of playing 3 or 4 versions, one after the other, chosen intuitively in real time. As a further touch, the sound (a physically modelled vibraphone, tuned microtonally) is then reverberated using convolution reverb. The reverb impulse is 10 seconds of John Cage reading from his text piece *Mureau.* This gives quite a lovely ghostly, interestingly shaped reverberation to the piece.

I wondered if Cage ever used these probability distributions in his pieces. William Brooks, composer, Cage scholar and friend, said he thought that Cage had worked with the Bias idea in the *Freeman Etudes,* (W. Brooks, personal communication, July, 2010), and although I know it's not the case that the IC program was used with *Cheap Imitation* (which was written about 13 or 14 years before IC was written), the kind of changing of modes that Cage used there could be seen as a prototype of the idea of changing probability distributions that would happen with the Bias setting. But the existence of these options shows that Cage's understanding of randomness and its mappings, was very sophisticated. The Bias option can generate pretty interesting results.

Just before writing the description of this investigation, however, I wrote to James Pritchett, whose magisterial *The Music of John Cage* is a model for contemporary analysis of random-based works, and asked him what he knew about Cage's use of "bias." His reply:

> Regarding "bias" and Cage's use of the I Ching: This is described in Cage's article "To Describe the Process of Composition Used in Music for Piano 21-52" (Silence, pp. 60-61). The term "bias" isn't used here, but the principle is the same. Note particularly step 6 (p. 61): "The sixty-four possibilities of the I-Ching are divided by chance operations into three groups For example, having tossed numbers 6 and 44, a number 1 through 5 will produce a normal; 6 through 43 a muted; 44 through 64 a plucked tone. A certain weight of probability exists in favour of the second and third categories."
> In his compositional process, Cage needed to map various choices onto the 64 possibilities of the I Ching. In the case of the Music for Piano above, he needed to map 3 onto 64. There are two ways to do this: evenly (or as evenly as possible), where each choice is equally likely; or unevenly, where some choices may be more likely than others. In the case of Music for Piano, he decided to do it unevenly, thus producing "bias". The bias itself was randomly determined: he used the I Ching to determine the two boundaries for the partition (in this case, 6 and 44). If he used that bias throughout, it would be "fixed bias". In many pieces, he would make this kind of partition repeatedly throughout the piece, changing it at randomly-determined points – "movable bias". Usually this would be done by getting an additional I Ching reading that would determine the number of decisions to be made before changing the bias again. I hope that makes it clear! You're not the first person to ask about it."
> (James Pritchett, personal communication, July 2010)

So, on the basis of his answer, I can see that even by the early 50s, Cage was dealing with the idea of weightings in randomness. His understanding of randomness

was already very sophisticated. So the use of "bias" and "immobile bias" well preceded the writing of the ic program, although the particular implementation of "bias" and "immobile bias" is probably a product of the mid-80s.

The Mesostic Process

A different kind of unpredictable result came about when Cage developed his "Mesostic" composition routines. The Mesostic process extracts a new text from pre-existing ones. The restrictive rules of the process guarantee a certain kind of "rhythm of extraction" from the target text. For the Cage 101 conference, I was asked to produce a performing version of Cage's "__ (title)__ (article) __ (nationality) Circus on __(pre-existing book)" that would be relevant to Malaysia. The novel chosen as the source text was Tan Twan Eng's *The Garden of Evening Mists.* So the title of our version was *Memento Memori: A Malaysian Circus on the Garden of Evening Mists.* Composing this version involved making mesostic texts from the original novel, recording hours of Malaysian environmental sounds, taking hundreds of photographs of locations described in the book (these last two tasks heroically accomplished by Catherine Schieve), compiling lists of sounds that occurred in the book, and arranging for staff and students at Universiti Pendidikan Sultan Idris (UPSI), as well as participants at the conference, to perform activities based on events in the book during particular time frames. The work was performed during the Cage 101 Conference at UPSI on August 23, 2013.

The mesostic process however, generates different results based on the source text one chooses for the work. The mesostic rule is that one has to go through the "mesostic spine" letter by letter, finding a word which has the required letter in it, but which cannot have the letter following that letter in it. For example, if one uses 'The Garden of Evening Mists' as the "mesostic spine", at a certain point, one has to find a word with 'V' in it (derived from the word "Evening"), but that word cannot have an 'E' following the 'V'. There are very few English words having a 'V' that do not have an 'E' following the 'V'. (Vary, vagary, vigour would all be possible, for example.) So at this point, in extracting the poem from the target text, one has to search for quite a long time to find the proper word. The use of this particular "spine" guarantees that large portions of the target text will be skipped over in the extraction process, and shortens the length of the potential text. If, on the other hand, one had used "Tan Twan Eng" as the "mesostic spine," the resulting text would have been much longer because all of the allowed combinations of letters (except perhaps "Tw" in the author's name) are much more common in English than the ones produced, for example by the 've' of "Evening."

Here is an example of the mesostic extracted from Chapter 15, one of the most dramatic in the novel. One can see that even though the text is a random extraction from a found text, something of the drama of the original does come through in the extracted   text:

sTains
sikH
mE
enGlish
recAlled
fRom
haD
hE
sleNder
fOrties
oF
thE
inVariably
askEd
questioN
dIscovered
beeN
chanGi
Malaya
In
hideyoShi
goT
hiS

palleT
tHough
hE
*an*G*in*
cAmps
moRe
Difficult
kEep
caN
yOu
For
mE
moVing
soundlEssly
carNage
hIdeyoshi
aNd
breathinG
froM
evenIng
guardS

<pre>
                              flighT
                                   Steps

                                   To
                                   Hanging
                          positionEd
                               tiGhtened
                               regAined
                                   Rites
                          beaDs
                          twinEd
                          arouNd
                                   Of
                                   From
                           thE
                           paVilion
                           havE
                           beeN
                           delIghted
                          heroN
                          winGs
                          theM
                          echoIng
                          treeS
                               waTer
                          bird'S
</pre>

For this realisation, I decided to just use words generated by the "spine text." The option exists to freely choose "wing words" on either side of the spine words, but for this version, I wanted to go for as stripped down a text as possible. Imagine my delight, then, when generating the text for this chapter, which deals with the execution of the war criminal General Hideyoshi, when the text "Hideyoshi got his" was generated. Also, in this chapter, the moment of the General's hanging is immediately followed by a scene of a heron flying over a lake. This is clearly reflected in the last occurrence of the "spine text" above, starting with "To Hanging PositionEd" and ending with "treeS waTer bird'S."

Summing Up

Every time I have realised a Cage score over the past 40 years, as a part of realising the piece, I have come to understand the process he used to generate that particular piece. In each case, I have seen that the works in question are very carefully constructed. In contrast to the image some have of Cage as someone who used random processes in a very slapdash way, on looking at the scores, one sees quite clearly the very crafty, and crafts-manly   compositional   mind   of   John   Cage.

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Biography

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Endnotes

[1] The World Intellectual Property Organisation's (WIPO) 2004 report on the economic contribution of the copyright industries to Singapore grouped music, theatrical works and opera as a single 'industry'.

[2] 'Definitions of the "creative economy" may vary, but it is generally agreed that at the heart of the creative economy lie the creative industries. There is no single agreed definition of the "creative economy" or the "creative industries" although clearly, they embrace the concept of "creativity" as an essential characteristic. Today, creativity is often referred to as a primary resource in the knowledge-based economy, leading to innovation and technological changes, and conferring competitive advantage on businesses and national economies' (United Nations, 2010, p.255).

[3] "The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint agreed to by all the world's countries and all the world's leading development institutions. They have galvanised unprecedented efforts to meet the needs of the world's poorest" (United Nations, 2014, online).