Me and the Random

Jim Andrews
vispo.com

Illustration 1: Fortuna, Goddess of chance depicted by Tadeusz Kuntze, 1754

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I.

The first time I used the random in art was in the 1980s when I produced a literary radio show. I'd been reading William S. Burroughs on his cut-ups in print and audio, and also had been reading McLuhan's writings on media. Before I started reading such things, I was convinced *nothing good* could come of the random in one's art. It's hard enough to create anything interesting when you have full control; how can you use randomness to create quality work when quality work is a matter of attending mindfully and imaginatively to every detail of the work?

I didn't understand that when you have many choices—where one choice, within a curated range of values, is as good as another—choosing randomly makes perfect sense. If you have enough such random parameters, then the process, which iterates over all those random choices, can explore the compositional space in an interesting, generative way.

My first work that used the random was an audio piece. I'd recorded parts of different TV shows and commercials. It was coming up to our radio station's fund drive. I wanted to create something funny for fund drive. I decided to threaten the audience with death if they didn't give me money. I listened to TV shows and ads for talk of improbable product claims, special offers and death threats. I'd make improbable claims about what my radio show could do for your personal life, offer them special offers and, if they didn't buy it, I'd threaten them with death. I ended up with a few piles of reel-to-reel tape. One pile was improbable product claims, one was death threats. Another pile was special offers. I can't remember what the other ones were. I'd use my voice to record something and then, when it was time for a product claim, special offer or a death threat or whatever, I'd grab a random one of that type and splice it in to the pre-recorded show. I was delighted with the surprisingly energetic results, and people even gave me money. Not much, but a bit. It was a different time. That sort of thing was sort of funny then.

In using the random, I was after a bit of the magic you glimpse when Burroughs proclaims *when you cut tape, the future leaks out*. His famous cut-ups in print and audio, in which he cuts stuff up and puts it back together randomly, are toward cutting the tape loops *in his own head*, getting beyond the artistic choices he would make *consciously*, and opening his art to voices from *beyond*, voices from the *future* or the *Interzone*, or voices from the *unconscious*.

The random is the *unpredictable*. That which is without *pattern*. The random is the chaotic, the unknowable. The random is on the *wild side*. It's *mysterious*. Whatever else

artists use the random for, I expect they're usually after a little bit of *that*.

In information theory, the random is also the *uncompressable*, the maximally informational. *Entropy*, a notion in both information theory and thermodynamics, is a measure of the randomness of a system; the greater the randomness, the greater the entropy. The more complete the disorder, the greater the entropy and randomness. Randomness is *disorderedness*.

And, of course, beauty is not without relation to the wild side, the unpredictable, the unknowable, the *mysterious*. Some artists have given up on beauty. Not me.

When I started this essay, I just wanted to sketch out how I use the random in my own art. But as soon as I finished one section, another would occur to me. Not just about my own art, but about other topics around randomness.

And certainly it's a topic of some depth—philosophically, mathematically, artistically, and historically. It's the dark side of order; it's an exploration of disorder, as well as order. Just as the *irrational* (the not ratio-nal) numbers were the dark side of the harmoniously ordered Pythagorean universe, the random is the dark side of the contemporary *informational order*. It is still the realm of *mystery*.

II.

Historically, chance has also been associated with *divination*. When Burroughs talks about the future leaking out when you cut into the present (or into audio tape), that's part of what he's referencing. Divination, or augury, which often involves dice or other chance operations to generate the client's fortune or an I Ching hexagram, or whatever, is often an attempt to *foresee the future*. The idea being that the dice, or the pattern in the flight of birds—or what is said when cut reel-to-reel tape is spliced back together randomly—is *not* simply random, but is *directed by spirits and hidden powers* who exercise mysterious influence upon the auspices.

The very idea of the random or of chance as *not* involving God or spirits but merely an unpredictable "concourse of atoms", although probably at least as old as pre-Socratic Greek atomism (Leucippus, 475 BCE), was overshadowed by more deistic world views until the formulation of probability theory in the time of Cardano in the sixteenth century and Fermat and Pascal in the seventeenth century; "...in the nineteenth century, Pierre Laplace completed what is today considered the classic interpretation."[1]

But it seems that even the most rational among us are more than a little prone to see at least some events of chance/randomness in terms of *personal narrative*; a roll of the dice in Yahtzee is secretly fantasized as whether she loves you, or whether you will get that job you're up for, or whatever. The history of dice whispers with gods and spirits:

> In later Greek and Roman times, most dice were made of bone and ivory; others were of bronze, agate, rock crystal, onyx, jet, alabaster, marble, amber, porcelain, and other materials. Cubical dice with markings practically equivalent to those of modern dice have been found in Chinese excavations from 600 BCE and in Egyptian tombs dating from 2000 BCE. The first written records of dice are found in the ancient

1 Wikipedia: en.wikipedia.org/wiki/Probability_theory

> Sanskrit epic the Mahabharata, composed in India more than 2,000 years ago. Pyramidal dice (with four sides) are as old as cubical ones; such dice were found with the so-called Royal Game of Ur, one of the oldest complete board games ever discovered, dating back to Sumer in the 3rd millennium BCE. Another variation of dice is teetotums (a type of spinning top).
>
> It was not until the 16th century that dice games were subjected to mathematical analysis—by Italians Girolamo Cardano and Galileo, among others—and the concepts of randomness and probability were conceived. Until then the prevalent attitude had been that dice and similar objects fell the way they did because of the indirect action of gods or supernatural forces.[2]

People have been *playing* longer than they have been rolling dice. Other animals *play*; we may have been playing before we became *human*, or even before we were ape-like, given that we see animals of considerably lower cognitive levels than apes *playing*.

Play does not require dice or a concept of the random, of course. Dogs, cats, and other animals don't seem to use anything like dice or have any sort of probabilistic notion of the random. But they do often play *with* something. And it's clear that there is some kind of *pretending* going on in their head. They feint and duck while looking at that ball they're playing with like it was going somewhere any moment now.

The point being that using our imaginations in play to pretend is *older than ancient* in our bones, and playing *with* things, too. Once play gets to the stage where we want some kind of *event generator* other than our own decision, the concept of unpredictability/chance, however laden with divinity, is born.

We say that the use of the random in art goes back to Dada in the early twentieth century. But the use of dice in board games goes back *at least 5,000 years*! It's thought that art basically goes back to modern humans somewhere from 42,000 to 150,000 years ago. I think it unlikely that dice of some sort, knucklebones, draughts, etc didn't get mixed with the art sometime in the last 42,000 years. As a way to let the gods speak, if nothing else.

Dada and Surrealism turned the random/chance into a theme of their program; there's an entire delightful book called *A Book of Surrealist Games*[3], some of which involve chance/the random. But the imaginative use of chance in art goes back *much much further* in our bones. That is why it's so intriguing to us. Tossing the dice isn't just fun cuz it's taking a chance and is part of many games. It's got a hot streak of *connection with our fantasies*, with pretending, with play, with imagination—it invokes fantasty, the gods, the mysterious. With art. Which is also all about those very things.

The separation of chance/random elements from art and literature was temporary, sustained only by a temporary poetics of complete authorial control over the entire process of art generation. We have arrived at a position where we view chance/the random more or less as a *literary device*, like metaphor and simile are literary devices.

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2 *Encyclopedia Britannica* entry on dice: britannica.com/topic/dice

3 *A Book of Surrealist Games*, Alastair Brotchie, Mel Gooding, Shambhala Redstone Editions, 1995

III.

The main thing I use the random for now is exploration of a *compositional space*. Though I'm also after the magic. I think of a compositional space as the set of *all possible screenshots* you could take of a program in action; it's the set of *all possible compositions* your program can create/generate. The compositional space involves various parameters/variables that have different values from frame to frame of the program's animation. Such as the positions of the objects in the art, their sizes, opacities, rotations, possibly their colors, backgrounds, borders, and so on. All the parameters that change from time to time. Giving these properties of the compositional space random values (constrained within some suitable range) is a good way to explore the compositional range of the space. Animation as iteration over a compositional space.

As opposed to giving the parameters values that are incremental by small amounts. Because, generally, there are enough possible parameter values that the number of possibilities is astronomical; giving the parameters small incremental values would result in exploring only a small part of the space. Like the difference between exploring the total space of the universe via the usual travel (inch by inch) or by appearing, from moment to moment, in random parts of the universe. Now you're near the beginning of the universe. Now you're someplace 4 billion years into the thing. Now you're near the end. You get a better sense of the *range* of the thing, maybe, than the inch by inch approach.

Another example: consider the compositional space defined by the bill bissett dirtee konkreet brush. This uses 300+ images (400+ Mb) of the concrete poetry of the poet bill bissett. Each time you view this animation, it's different from the previous time cuz of the use of the random. The size of the circles are random, as are the bill bissett poems chosen to fill the circle; so too the size and position of the poems, and so on. There's *a lot* of random choices. This explores the compositional space more interestingly than if each of those parameters was incremented by a small number each frame of the animation.

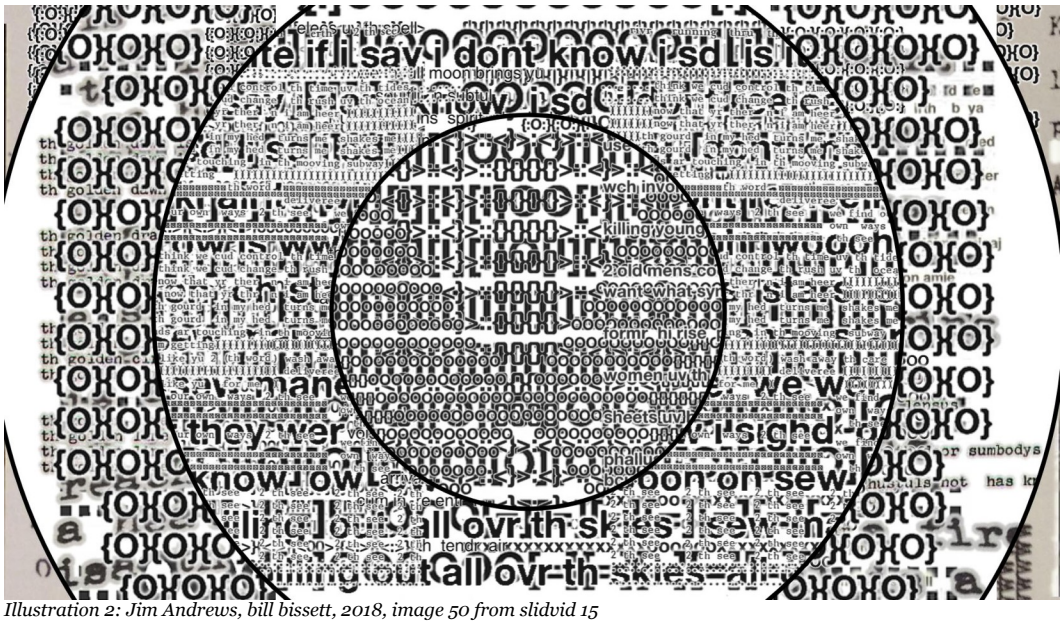

Illustration 2: Jim Andrews, bill bissett, 2018, image 50 from slidvid 15

Years ago I called a compositional space a *combinatorium* when I was developing the stir fry texts. I thought of a combinatorium as the set of *all possible texts* (or screenshots) that

can be created from a particular stir fry text. Once you get into programmed art, you eventually start thinking about compositional spaces or combinatoriums or whatever you want to call the set of *all possible texts or screenshots* that your program can generate. Or, if it's more narrative-oriented, you're thinking about the set of *all possible paths through some kind of story space*.

Sometimes navigating those spaces via random position is desirable. Sometimes not. The programming of the stir fry texts doesn't use the random at all. Change happens incrementally where the wreader mouses/stirs the text.

I don't make my art so that everything it generates is good. I make it so that the possibility hopefully exists of *some* strong work being generated. My philosophy is that if you want that possibility, you've also got to let shit happen. If everything that the system can generate is more or less equally good, then nothing is exceptionally good.

In my work, most of the generated instances aren't as well-formed as *a few* of them. In most of my generative visual works, I take screenshots of what I take to be good ones and present those screenshots in slidvids such as slidvid26 in which you see 100 screenshots of Aleph Null chewing on bill bissett, Jim Leftwich, and alchemical cosmography. Similarly, contrast vispo.com/aleph3/an.html?d=Jim%20Andrews with vispo.com/aleph3/images/jim_andrews/slidvid . The former is Aleph Null chewing on 230 photos of Trump, his cabinet, his advisors, and a few Republicans. The latter is a slideshow of 430 screenshots from that dynamic animation. The dynamic animation does a lot of *becoming*; it doesn't look particularly face-like, often. But sometimes a real gargoyle pops out, momentarily. Those are the sort of screenshots I'm interested in. The compelling ones (evil, ridiculous or whatever). They aren't morphs. Morphs carefully map noses to noses and eyes to eyes etc. In these ones, the position of the eyes varies between photos. Same with the other features. So that sometimes the dynamic animation doesn't look face-like. But the range of position of features is what makes for some unique, compelling results, occasionally.

The range within which the random varies is large enough that there's real variation, but small enough that the range fits more or less loosely in its context.

The experience of looking at the screenshots is different from the experience of viewing the dynamic animation. The dynamic, never-quite-the-same-twice animation has a raw, protean energy. The experience of viewing the slideshows, on the other hand, is one of slowly viewing a series of *completed* compositions.

The dynamic animation is dynamic largely through the use of the *random* to determine the values of many parameters from frame to frame of the animation. The slideshows involve less randomness.

In the dynamic animation, to some extent the animation is iteration, iteration through possibilities. The animation engine is an iterator through generative possibilities. As opposed, for instance, to providing an illusion of continuous motion through a space.

IV.

Here's what I think is an interesting use of the random. Each 'brushstroke' is a circular daub of a sample from one of 230 images of Trump, his cabinet, his advisors, and a few Republicans. I wanted the position of the brushstrokes to be random—but I wanted the brushstrokes to occur near the centre of the screen more often than at the left or right

edges of the screen. Cuz the composition is happening primarily at the center.

Illustration 3: From The Moral Deformity of Team Trump, Jim Andrews, image 326, 2018

It's easy to create a random number in a given *range* of numbers, but it isn't so easy to increase the frequency *in one part* of the range.

This function returns a uniformly distributed random integer between `min` and `max`.

```
function randomInteger(min, max) {
    // Returns a random integer between min and max.
    return Math.floor(Math.random() * (max - min + 1)) + min;
}
```

In JavaScript, Math.random() returns a number between 0 and 1. The probability of it returning any number between 0 and 1 is the same. That's why it's called a uniform distribution. But I wanted to create a non-uniform distribution.

It turns out that the following solves the problem.

```
var x1 = Math.random();
var x2 = Math.random();
var x3 = (x1 + x2)/2;
```

Both `x1` and `x2` are random variables between 0 and 1. So too is `x3`; it's the average of `x1` and `x2`. But `x3` is more likely to be a value near 0.5 than a value around either 0 or 1.

We can see the graph of this distribution in something I wrote at random.htm. It's called *the Grace Bates distribution*. The *x* axis is the average of the given number of Math.random() variables. Since Math.random() is a number between 0 and 1, the average is also a number between 0 and 1. The *y* axis is the number of occurrences of the *x* value in *x*-axis intervals of length 0.001. You can make it cluster more tightly around 0.5 by increasing the number of Math.random() variables. Like so:

```
var x1 = Math.random();
```

```
var x2 = Math.random();
var x3 = Math.random();
var x4 = (x1 + x2 + x3)/3;
```

`x4` is the average of `x1`, `x2` and `x3`. Like, in the previous example, `x3` was the average of `x1` and `x2`. You can see the graph of this second example if you visit random.htm, change the 2 to 3, and press the button that says "Set num of Math.random() vars". You see that the resulting graph looks like a bell curve.

The Central Limit Theorem says that as you increase the number of `Math.random()` variables, the distribution gets closer to a *Normal* or *Gaussian* (bell-shaped) distribution. Also, the standard deviation (the average deviation from the 0.5 mean), decreases. The lower the standard deviation, the tighter the clustering around the mean (average) value.

In vispo.com/aleph3/an.html?d=Jim%20Andrews, the Trump piece, I used the average of 3 `Math.random()` variables and then multiplied that by the width of the browser to give me the *x*-component of the centre of a brushstroke's circle. That made the brushstrokes cluster around the *centre* of the screen, where the faces are located. The *y*-component of the brushstroke was simply `Math.random()` multiplied by the height of the browser, a uniformly distributed random variable between 0 and the browser height.

Illustration 4: Image 179, slidvid 10, From Alchemical Cosmography, Jim Andrews, 2020

To me, changing the values in the boxes at random.htm offers an interesting *experience of the random*. As you increase the number of trials, the graph gets smoother. Compare how it looks when the "Set num of trials" box is set to 100,000 (the default) versus when it's set to 1,000,000. It's like zooming in and out of pictures of physical things; zoomed *out*, they're fully distinct and strong lines separate them from other things, but when you zoom *in* at the atomic level, the borders get much fuzzier.

When you change the values in the "Set num of `Math.random()` vars" box, you experience the Central Limit Theorem, especially when it goes from 2 to 3. You see the

graph turn into a bell-shaped curve and then, as you increase it further, how the curve clusters more tightly around 0.5.

This is math experience, *experience of math ideas*. You get a better *feel* for the random. Getting a *feel* for the random by understanding the math of it is interesting, to me.

Even if you don't change any of the numbers but just click the buttons repeatedly at random.htm, you *experience the random*. Each time you click a button, it does the same thing, but the graph looks a bit different. By default, it calculates the average of two random variables 100,000 times and graphs the result. Yet, while it doesn't look *exactly* the same, each time, it looks *roughly* the same. You still see that pyramidal distribution, the Grace Bates distribution. Why? Why is it always pyramidal? Because for it to be otherwise would be *extremely* improbable. Not *impossible*, but *astronomically* improbable—so improbable that it only happens once in the lifetime of a *gazillion universes*. Or, you know, somewhere *around* there.

V.

Let's look briefly at a question prompted by the previous example: how would you construct *any* given probability distribution?

You can see the general idea of how to construct such a distribution in the following code, which I got from Sergio Tulentsev at stackoverflow.com. This function returns an integer from 1 to 4 where the probability of getting a 1 is 4/10; the probability of getting a 2 is 3/10; the probability of getting a 3 is 2/10; the probability of getting a 4 is 1/10.

```
function randomWithProbability() {
    var notRandomNumbers = [1, 1, 1, 1, 2, 2, 2, 3, 3, 4];
    var idx = Math.floor(Math.random() * notRandomNumbers.length);
    return notRandomNumbers[idx];
}
```

The idea is you construct an array that contains the possible values, and you construct the array so that each value has the weight you want it to have. Then you pick a random element of the array. An array of size 10 is good for purposes of illustration, but for more accurate results you'd probably want an array of size 1000 or 10,000 or possibly 100,000.

The continuous case involves some curve fitting and some calculus, so we'll skip it.[4] Rather than needing to construct any old distribution, I expect what's more usual is constructing a distribution that clusters around a *particular value* and has specifiable *max* and *min* values. The following works when the desired mean is (*min* + *max*)/2.

```
function getRandomValue() {
    // Returns a random number between min and max. The
    // distribution is bell-shaped with mean (min+max)/2.
    var numOfRandomVars=3;
    var sum=0;
    for (var i = 0; i < numOfRandomVars; i++) {
```

4 The basic idea, I think, is you fit a polynomial through the desired points in the curve. You have to solve a differential equation to do it, I think (fit the curve through the local maxima points or inflection points). Then you integrate it between the lower and upper x values. That gives you the area underneath the curve. You want then to translate the curve up or down so that the area under the curve is 1.

```
        sum += (max - min) * Math.random() + min;
    }
    return sum/numOfRandomVars;
}
```

The above function has a bell-shaped distribution with a mean of (*min*+*max*)/2. If you want it to cluster more tightly around the mean, raise the value of `numOfRandomVars`. The lowest value it will return is *min*; the highest value it will return is *max*.

VI.

If you read about the use of chance and randomness in art, over the years, you see that in the hands of artists such as Jean Arp, in the time of Dada (1915-1920), the use of chance in visual and literary composition, being new(ish) was, at the time, shocking, dramatic, and provocative. It was a *disordering* of reason and logic; this was the time of World War I, where reason and logic were predominantly of death and destruction. Art and the world were in the death throes of the world as it had been. Dada, and its introduction of chance and the random, was anti-art. But anti-art turns out to be serious art, sometimes, turns out to be rejuvenating in its innovations outside of the norm and standard art. It opens art up to what it was previously closed to—if it is not only anti-art but trying new things.

A little later, when Freud and the unconscious became prominent, the Surrealists favored the random as a way to cut through the expected to the *unexpected* juxtaposition of images by chance or phrases/words by chance toward liberating the unconscious. In Surrealism, the use of chance is less political than psychological. It was thought that in the absence of *conscious* decision-making, the *unconscious* could work itself into or around chance decisions. When we think of the surreal, we think of dream-like, strangely juxtaposed hybrid beings and things. The juxtapositions are sometimes the result of chance, and sometimes free association.

In the sixties, we see somewhat more ambitious uses of the random. Its use has graduated to something central to the creation, say, of a trilogy of novels, as in the case of Burroughs's *The Ticket that Exploded*, *The Soft Machine*, and *Nova Express*. That warped my mind for months. These are Burroughs's most radical experiments with random cut-ups. In *Naked Lunch*, he'd done *a bit* of it. But nothing to the extent that you encounter in the trilogy.

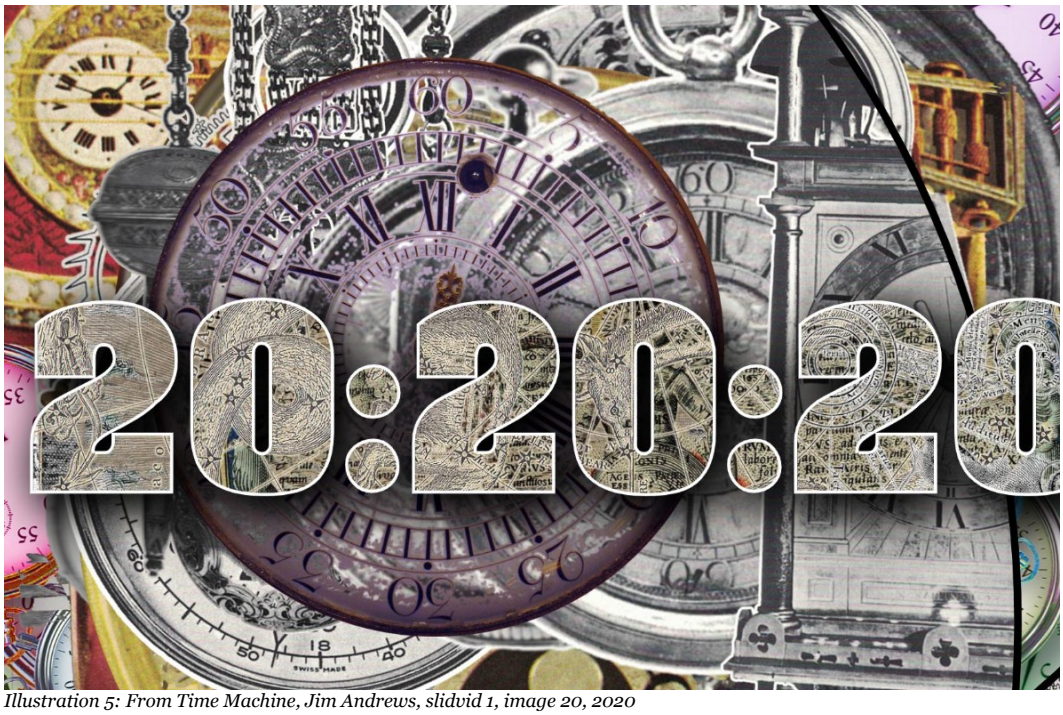

Illustration 5: From Time Machine, Jim Andrews, slidvid 1, image 20, 2020

Also, Burroughs's writings about his methods are fascinating. At least as fascinating as the trilogy itself. Maybe moreso. He developed not only the trilogy but a *whole accompanying poetics* of the cut, of chance, of technology in art and writing. You see huge influence on him from Dada and Surrealism.

> "I don't know about where fiction ordinarily directs itself, but I am quite deliberately addressing myself to the whole area of what we call dreams."[5]

His work is dream-like, hallucinatory, drug-inflected. Mind-altering technology.

Burroughs's cut ups operated at the level of *the phrase*. It's hard to create whole novels if chance is operating in *the word-by-word* construction of the text, which is what you see in the earlier literary constructions, usually, of Dada and Surrealism. That'd be a novel-length word salad. Which is why the aleatory works of Dada and Surrealism are generally *short*. But if chance is operating *phrase by phrase*, there's more of the original remaining than a remnant. It's more prosy. What Burroughs normally did was cut pages of writing into four pieces via bisecting the page vertically and horizontally, shuffling the parts, and reassembling randomly. Then he'd work that, to some extent. So whole quarter-pages are in the same area, separated phrase by phrase.

Size matters, in cut ups: it determines how much of the original semantics remains. When I first met Kedrick James he asked me if I knew why cut ups of cut ups didn't work as well as cut ups. I was stunned that he'd asked me such a question. I had actually thought about it and knew the answer, but hadn't talked about it with anyone.

5 William S. Burroughs, The Third Mind, Viking, 1978

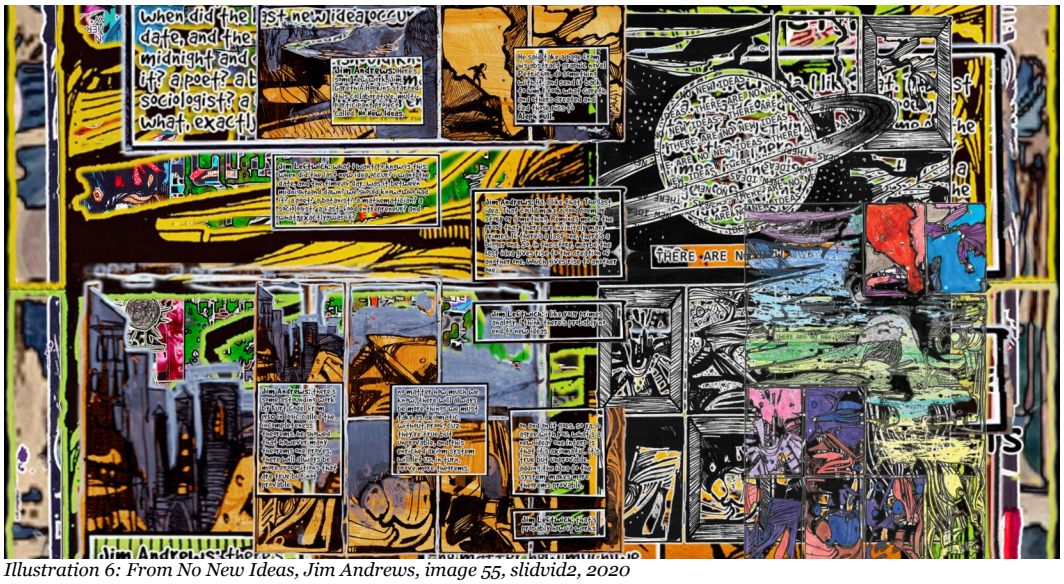

Illustration 6: From No New Ideas, Jim Andrews, image 55, slidvid2, 2020

Cut ups operate at the level of *the phrase* (a half-page width), whereas cut ups of cut ups usually operate at *half that width*, at the level of just a *couple of words*. Cut ups of cut ups are almost random word-by-word constructions, whereas cut ups are phrase-by-phrase constructions, which retain more of the original voice, logic, intent, subject, predicate, thought, emotion, etc. (semantic structure) of the original writing.

Oulipo in France began in 1960. This was also a very important development in the use of the random. I think of Oulipo as the first significant synthesis of math and literature. If Burroughs was serious about aleatoric literature, Oulipo took it to a higher level of complexity and theoretical sophistication. There are plain old writers in Oulipo, but there are also mathematicians and, now, no doubt, computer scientists. From the start, they've been *quite* cheeky; at least some of them were more interested in the *algorithms* than what the algorithms *produced*.

The use of the random in literary matters has gone from a parlor game to whole word processors that offer writers all the random and permutative, combinatorial methods that artists have used for the last hundred years—and more. Two brilliant friends of mine, Dave Ayre and Andrew Klobucar, are nearing completion on The Language Workbench, their first commercial word processor for experimental writing; a previous iteration was non-commercial and written in Java.

> Technically, this software project means to explore how creative writing (and language use in general) might take advantage of digital processing applications to create new and innovative forms of literary art, electronic or otherwise. The tool can best be described as a digital studio for language which allows for any number of literary and aesthetic modifications to texts, similar to the way current graphic design software like Photoshop and audio software like Sound Forge permit artists to create, modify and combine different visual and sound pieces.[6]

Not all of the text filters The Language Workbench offers involve randomness, of course; some of them transform all the nouns, say, in a selection, or all the adverbs, or whatever.

6 Ayre and Klobucar describing The Language Workbench at web.njit.edu/~newrev/3.0/workbench/Workbench.html

But some of the filters *do* involve randomness—and The Language Workbench offers not only a stunning array of new text transformation tools, but all the classics such as Burroughs's cut-up method, Oulipo's N+7, and so on.

There are already writers, such as Dan Waber and Alan Sondheim, who have been using a battery of software they've accumulated over glittering careers of striking writings that combine chance with insight and remarkable writing.

These artists approach the use of chance and the random with unprecedented sophistication and knowledge of historic poetics of the aleatoric from the Paleolithic to contemporary networked computing, from the shamanistic to the post human, from the technologically challenged to the mathematically algorithmic.

Two friends of mine, Ted Warnell and Chris Joseph, fellow programmerly net artists, visual poets, and multi/inter media artists, use the random in their programs much as I do. Among other things, we use it to create works that are never-quite-the-same-twice or, as Ted puts it, works that are "alinear". We use it, among other reasons, to explore permutations within a compositional space, which is saying much the same thing, I think, as that we use it to create works that are never-quite-the-same-twice.

The famous use of the random doesn't have as long a history as the use, say, of *metaphor*, another *literary device*, but it has enough documented history, now, to be viewed in a similar light as *literary devices* like metaphor or simile or whatever. It's a *literary device* and deep subject that draws in many philosophies and poetics, historically and conceptually. It's use will continue to develop alongside new technologies and poetics of the word, image and sound. The last word has hardly been uttered on the matter.

VII.

But all this time, we've been talking about 'randomness' without defining it. That's what I want to do in this section. I want to define 'randomness' in terms of the *absence* of three inter-related ideas:

1. predictability;
2. patternedness;
3. compressability.

What I want to show you in this chapter is that these three things are different perspectives on the *same thing*: what is *predictable* is patterned and compressable;

what's *patterned* is predictable and compressable; and what's *compressable* is predictable and patterned. You can't have one of them without having the other two in equal measure. That's what I want you to understand by the end of this chapter.

The meaning of the word *random* has changed dramatically since the work of Cardano, in the sixteenth century, and Fermat and Pascal, in the seventeenth century, created probability theory. Before then, *random* referred to an impetuous, headlong gallop or running. It referred to impetuosity at full speed. Randomness as Wayne Gretzky streaking down the ice on a breakaway coming at you, the goalie. Randomness incarnate. Or you're in the middle of a street and there's an escaped horse galloping toward you. What's it going to do? Pure randomness—unknowable, dangerous, fateful.

Illustration 7: Jim Leftwich, Jim Andrews, image 201 from slidvid 4, 2019

However, although we think of randomness differently now, that isn't without relation to its current meaning, because one of the chief meanings it has now is that what's random is *unpredictable*. The random, since probability theory, has been mathematized. It is analyzed within a recorded *sequence of events*. Thinking about the random now is a matter of thinking about unpredictability within a sequence of events or elements.

Also, when we say that randomness is *unpatterned*, we mean that the *sequence of events* is *unpatterned*. The sequence of coin flips or dice tosses, or whatever. And such sequences, written down, become files that can be *compressed*—or not, if they're purely random, as we'll see. That's how compressibility enters into our discussion of the random.

What does it mean to say that a sequence of coin flips is random, really? It means that it lacks all pattern; it is utterly without pattern; it does not hold to any pattern whatsoever. If it held to a pattern, it would be predictable, and so not random. Anything that is predictable is predictable because it displays a pattern. If the coin is biased, it ends up showing one side more frequently than the other. That's a pattern.

If something is unpredictable, it's without pattern. If something is without pattern, it's unpredictable, because we use patterns to predict things. To the extent that something is predictable, it obeys/displays a pattern. And to the extent something is patterned, it is predictable, because pattern extends into the unknown, filling in the gaps, making it known. Pattern is precisely what allows us to make any predictions we make.

So we now understand the logical equivalence of *patternedness* and *predictableness*. They are different perspectives on the same thing. Where we have one of these things, in some measure, we have the other—to the same degree. To the extent that we lack either, we lack both, and to the same degree. That which is perfectly random is entirely without pattern and is perfectly unpredictable. To the extent that something is patternless or unpredictable, it is random.

But I said I wanted to define randomness in terms also of *compressability*. You've probably dealt with zip files before. Zip files are files that have been compressed, that is, made smaller by a compression algorithm. Compression algorithms read a file and sometimes are able to code it in such a way that the resulting file is *smaller* than the original file-size. And the zip program that zipped it up can also *unzip* it to give you the *original* file back.

Files are often zipped up for transportation. The fewer bytes you have to transport, the smaller the time it takes to transport the file from point A to point B. Also, the smaller the file, the less space it takes up on a hard drive.

Illustration 8: Fortuna, Roman goddess of fortune/luck.

How do compression algorithms compress files? They look for *patterns* in the file. If a file consists of ten trillion zeroes, I have already told you enough that you can reconstruct the file character-for-character. The file is long but the *pattern is simple*; the file is long but it *doesn't contain much information*. All you need is the *pattern* to reconstruct the file *character-for-character*. "The file consists of ten trillion zeroes." That sentence is 40 characters long. That's a lot shorter than ten trillion characters! But all you need is the 40 characters to be able to reconstruct the file with *perfect accuracy*.[7]

Compression algorithms looks for *patterns*. That's how they compress information; they replace parts of the file with the repeating pattern. The simpler the pattern, the shorter the description of the pattern.

If, on the other hand, a file contains *no* patterns, then it's *not* compressable. Because compression algorithms compress by finding and using patterns. We've already said that if a file contains no patterns, it's random. That's what we mean by randomness; it contains no patterns and is unpredictable. We see now that if it contains no patterns, that also means that it is not compressable. And, conversely, to the extent that it does contain patterns, to that extent it also is compressable.

So we see that *compressability*, *predictability*, and *patternedness* are three ways of looking at the same thing: the amount of information in a string[8]/file. Random strings can't be compressed; they hold the most information of any string of their length. And random strings are unpredictable and totally lacking in pattern. Random strings have 0 compressability, 0 patterning, and 0 predictability. If we take compressability to measure

7 My article Word Vices (vispo.com/writings/SeveralNumbersThroughtheLyric/WordVices.pdf) describes the Huffman and Lempel-Ziv compression algorithms.

8 A 'string' is just a sequence of characters.

the amount of information in a string, random strings are maximally informational cuz they're not compressable whatsoever.

VIII.

Now that we've worked out a definition of randomness (something is random to the extent that it's *unpredictable*, *uncompressable*, and *unpatterned*) I'd like to ask how we measure the *degree* of randomness present in something.

The degree of randomness depends on the degree of unpatternedness. So if we search for all possible patterns and don't find any patterns, that must mean the data is perfectly random.

But wait. How many possible patterns are there? A little reflection will convince us that there are infinitely many possible patterns, depending on how we define *pattern*.[9]

And that spells trouble. We can't check for the presence/absence of infinitely many patterns, or even astronomically many patterns. That means that when we say something is random, we mean that it lacks the patterns we *searched* for. Not that it is *utterly* without pattern.

Even if we keep the number of possible patterns down to a finite number, the problem is still intractable. For instance, suppose we limit the number of possible patterns to all possible functions from the symbol set of the string back into the symbol set. If the symbol set has x characters in it and the string in question is y characters long, then the number of functions is x^y. If the symbol set is the English alphabet of 26 symbols and the message is 80 characters long, the number of possible functions is 26^{80}, which is way more than the number of atoms in the universe, which is estimated to be around 10^{80}. So forget about checking them all. It won't happen in this universe anytime soon.

However, as is pointed out in the Wikipedia article on random sequences, various practical degrees of randomness have been advanced and the corresponding tests are compression algorithms that measure the data's ability to be compressed according to relatively useful criteria.

IX.

A “pseudorandom number generator” (PRNG) is a piece of software that generates sequences of numbers that, while capable of passing all tests for randomness, in the case of the best ones such as the Yarrow algorithm and Fortuna, are considered to not be *genuinely random*.

We said that something's random to the degree that it's unpredictable. So, some argue that so-called “pseudorandom” number generators (PRNGs) are not generative of *genuinely random data*, and that we need to look to natural or hardware processes for genuinely random data. Let's look at this.

A PRNG is basically a math function. You feed it an input number and it generates a

9 To convince you that there are (potentially) infinitely many possible patterns, let's define a pattern as a segment that repeats. For instance, the string 'abcabcabcabc' simply repeats 'abc'. Another example: '15151515' repeats '15'. Each integer is a pattern that can be repeated. And there are (potentially) infinitely many of them.

random output number calculated from the input. If you put the same input number in it twice, you'll get out the same output number both times. If you know the input number, you can be quite *sure* of the output number. That, of course, is not unpredictable at all; if you know the input number and you know the function used by the generator, you can predict the output with complete certainty.

Mind you, if you *don't* know the input number, PRNGs can be extremely *unpredictable*. There are PRNGs that are certified as secure for serious cryptographic purposes; it's possible to make a pseudorandom number generator such that it's pretty much impossible to ascertain the input number, or the “seed”, as it's called. In that case, is the data genuinely random?

As we noted earlier, it's impossible to test for the absence of all patterns in a sequence of random numbers. But there are 'standard' tests of such sequences of numbers. And a few pseudorandom number generators are good enough to pass those tests. Such as the Yarrow algorithm (incorporated in Mac OS X and FreeBSD) and Fortuna. Wonderful names, of course, given the yarrow stalk method of generating a hexagram in the I Ching. And Fortuna was the Roman goddess of fortune and the personification of luck.

Those tests for randomness have not only to do with the security of the “seed” so that the PRNG cannot be predicted by virtue of knowing the “seed” (input). They also test for the randomness of the distribution of the values throughout the sequence. And they test for the presence of patterns in the sequence of numbers, patterns that can result from periodicity, for instance, so that after some period, the same values repeat. The decimal expansion of pi is not a terrible PRNG because pi, being an irrational number, does not have a decimal expansion that repeats a fixed-length pattern of digits, unlike all rational numbers[10].

Illustration 9: Jim Andrews, Daniel F. Bradley, image 103 from Erogenous Zones in Aleph Null

10 A rational number is one that can be expressed as a/b where a and b are whole numbers.

X.

The last thing I want to talk about is the work of the mathematician/philosopher Gregory Chaitin. I recommend his book *Thinking About Gödel and Turing*. There are all sorts of Chaitin essays on randomness such as "Randomness and Mathematical Proof" , "Computers, Paradoxes and the Foundations of Mathematics", and "How Real Are Real Numbers".

Gödel and Turing are two of my favorite poets. Their engagement with language is *intense*, though they don't write poemy poems. They wrote poems about the outer limits of thought and computers. Chaitin situates their work and mathematics amid a vast ocean of mostly *random truth* in which pattern is only occasionally present. Fascinating work, and a new philosophy in which the random is as fundamentally present as in the physics of the movement of particles.

Also, I like his approach to *writing*. He writes with *passion* and personality. He doesn't attempt to erase his personal voice from the writing, unlike mathematicians who reach for *objectivity*. Also, unlike some mathematicians, he doesn't have a *golly-gee* voice, although there's no shortage of wonder and amazement. And the ideas are inspiring.

One of the fascinating aspects of Gödel's revolution of logic/philosophy is the mapping of language into number ("Gödel numbering"). Chaitin builds on that idea. In his *algorithmic information theory*, propositions/theorems/axioms of formal systems are mapped to strings of 0s and 1s. And inference from theorem to theorem becomes tracing of pattern in strings. We see inference as functional tracing of patterns from string to string. And we see an ocean of strings, of truths, most of which are true for no reason whatever, true by random. He shows us that most truths are unprovable. Correspondingly, most real numbers are not computable—only countably many are computable; the *vast* majority are uncomputable. No finitistic algorithm can calculate them to an arbitrary precision. They're without pattern. Incompressable. Maximally random, like Chaitin's Ω.

The transformation from looking at formal systems as propositions in language to binary strings, and inference as functional tracing of patterns from string to string, is a bit like the revolution Descartes wrought in transforming the way we looked at geometry into equations in a coordinate system. Suddenly the problem of, say, the squaring of the circle became not a problem in geometric construction with tools like the ruler and compass, but a problem in algebra of whether a system of simultaneous equations had a solution.

In terms of art, which is my main bailiwick, of course, it represents a further entangling of language and the visual, of language and code, of language and the random, of language and computer science, of language...

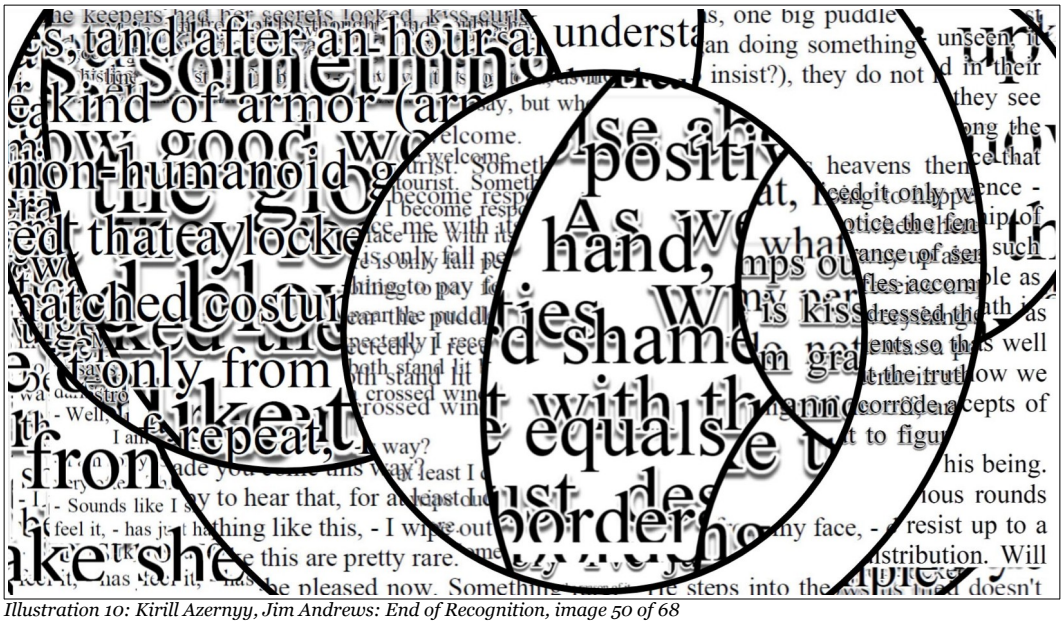

Illustration 10: Kirill Azernyy, Jim Andrews: End of Recognition, image 50 of 68

Illustration 11: Screenshot from Enigma n[2022]

Illustration 12: Screenshot 96 from Enigma n²⁰²²

Illustration 13: Screenshot 45 from Enigma n²⁰²²

Illustration 14: Screenshot from Sea of P_o: The Generation of the Ten Thousand Things

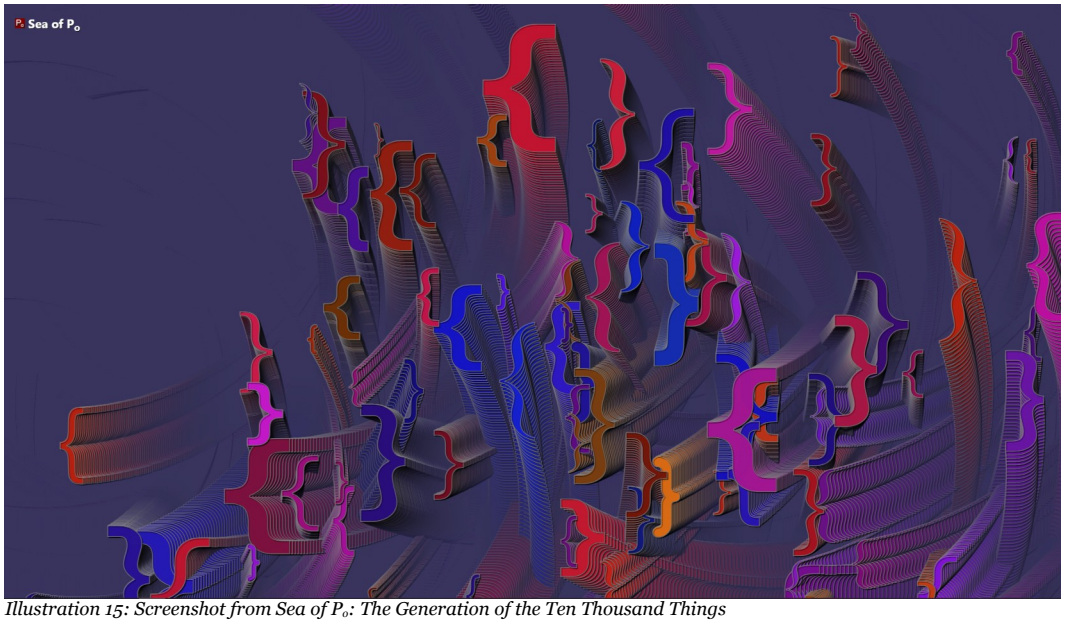

Illustration 15: Screenshot from Sea of P_o: The Generation of the Ten Thousand Things

Bibliography

- *A Book of Surrealist Games*, Alastair Brotchie ed., Shambhala Redstone Editions, 1991
- *Oulipo Compendium*, Harry Matthews, Alastair Brotchie, ed., Atlas Press, 1998
- *The Third Mind*, W.S. Burroughs, Brion Gysin, Viking Press, 1977
- *Thinking about Gödel and Turing - Essays on Complexity*, Gregory Chaitin,World Scientific, 2007
- *Randomness and Complexity from Leibniz to Chaitin*, edited by Cristian S Calude, World Scientific, 2007
- *Chance, a perspective on Dada*, Harriett Watts, UMI Research Press, 1980
- *Ten Great Ideas About Chance,* Persi Diaconis and Brian Skyrms, Princeton University Press, 2018
- *Algorithmic Randomness and Complexity*, Rod Downey, Denis Hirschfeldt, Springer, 2010
- *The Jungles of Randomness*, Ivars Peterson, John Wiley & Sons, 1997
- *Chance*, Margaret Iversen ed., MIT Press, 2010
- *The Taming of Chance*, Ian Hacking, Cambridge University Press, 1990.
- Word Vices, Jim Andrews, vispo.com, 1996.
- Random Sequences: Wikipedia: en.wikipedia.org/wiki/Random_sequence
- Algorithmically random sequence: Wikipedia: en.wikipedia.org/wiki/Algorithmically_random_sequence
- Pseudorandom binary sequence: en.wikipedia.org/wiki/Pseudorandom_binary_sequence
- History of Randomness: Wikipedia: en.wikipedia.org/wiki/History_of_randomness
- Pseudorandomness: Wikipedia: en.wikipedia.org/wiki/Pseudorandomness
- Pseudorandom Number Generator: Wikipedia: en.wikipedia.org/wiki/Pseudorandom_number_generator