Pata or Quantum: Duchamp and the End of Determinist Physics

The early 20th Century saw a breakdown, a deconstruction if you will, of the classical Enlightenment assertion that the world is fundamentally knowable to us. In the art and philosophy of the Enlightenment era, the rational capacity of the human mind to analyze and comprehend itself and the world was trusted implicitly. In science, the classical Newtonian physical model was the dominant paradigm. This model held that given sufficient knowledge of a physical system's initial state, its behavior could be understood and predicted completely. Everything in the world that was hidden or obscured could in theory be explained and brought to light by the proper application of human reasoning. But beginning with mathematical thinking in geometry done in the 1860s, these enlightenment ideals began to lose their hold on the world of ideas. Work done in physics, psychology and art began to reformulate a picture of reality that was less certain, and involved more risks.

The current of ideas that carried modern thought away from this determinist position was varied and complex, spanning many disciplines and years. This essay is an attempt to explore some connections and parallels between the art of Marcel Duchamp and developments in modern physics that question the existence of a rational, predictable world. As part of Duchamp's work, he created fictional, quasi-scientific systems that he worked into his visual designs. Calling these playful systems "pataphysics," he used the current scientific thinking of the time in a satiric way, making fun of rational, determinist systems and celebrating interesting new developments that cast doubt on traditional thinking. The most complex of these systems is described in The Bride Stripped

Bare by Her Bachelors, Even, also known as the Large Glass (begun in 1912). Important insights can also be drawn from 3 Standard Stoppages (1914) and the theories inherent to the Readymades (executed between 1913 and 1917).

The scientific groundwork for some of Duchamp's ideas in these works comes from investigations of non-Euclidean geometries, concepts of 4th dimensional space, work done on x-rays, radiation, and electro-magnetism. Later developments in science, especially the foundations of modern quantum mechanics, continue the trend of less deterministic ways of viewing reality, almost re-iterating some of Duchamp's playful science fiction as science fact. The Heisenberg Uncertainty Principle contextualizes scientific measurement, considering the impact of the viewer on the object being viewed, and introduces an irreducible uncertainty as to the exact energy states of basic particles. Erwin Schrödinger's set of quantum equations (which links the particle/wave behaviors of electrons, photons, and other particles) expresses their movements in terms of statistical probability fields, such that it becomes meaningless to talk of the particle as having a distinct position at any given time.

This breaking down of assumptions concerning the predictable, rational behavior of the world in Duchamp's work and in the sciences shares traits with several movements that emerged in and around World War I. Groups like the Cubists, the Futurists and the Dadaists shared a mission of transforming perceptions of the world in order to change how people relate to the world. While it can be difficult to interpret the true intent of the (often contradictory) manifestos and performances of the Dada group, we may try to deduce some valuable structures from their story. Rebelling against the rationalist social structures responsible for the devastating war, Dadaists attempted to create new languages for artistic (or even anti-artistic) expression. The Dada project recognized the inadequacies of existing forms of expression to compass a real understanding of the changing world, and sought to destroy all rationalistic cultural norms in art. By satirizing, mimicking, and distorting the systems they attacked, the Dadaists may have sought to demonstrate the inadequacies of their targets and point the way to the possibility of better forms. In a way, the Dadas acted as a sort of social resistor, slowing down the cultural machinery of the time, helping to re-orient society in a different direction. Duchamp, who is often seen as a sort of cultural father to the Dadaists, had a large impact on this cultural resistance that has been extensively researched and discussed. But the scientific inquiry in his pataphysics and the ways it might be seen as an antecedent to current thinking in quantum physics has not been adequately explored.

The word "pataphysics" was first introduced in 1893 by playwright Alfred Jarry who was attempting to create what he called a "science of imaginary solutions." As historian Linda Henderson explains, "Jarry was deeply interested in contemporary developments in science and geometry, which offered a means to challenge traditional positivism" (Henderson, 47). One of these developments was the mathematical description of non-Euclidean geometries.

Classical geometry, as first formulated by Euclid in Alexandria circa 300 BCE, has within it the fundamental assumption that two parallel lines will extend indefinitely and never meet. This assumption was held to be a priori fact until work done by Carl Friedrich Gauss, Georg Riemann, and others around the 1860s pointed the way toward internally consistent geometrical systems that behaved very differently from the classical model. While working in a Paris library in the early 1910s, Duchamp was exposed to the writing of French mathematician Henri Poincare, whose writings in support of the new mathematical models against the Enlightenment traditions of classical rationalism were an inspiration to him.

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Figure 1
Marcel Duchamp,
3 Stoppages Étalon (3 Standard Stoppages), 1913-14, wood, glass,
threads, varnish and glass. Katherine S. Dreier Bequest, The Museum
of Modern Art, New York © 2000 Succession Marcel Duchamp, ARS, N.Y./ADAGP,
Paris

The work that most exemplifies Duchamp’s interest in non-Euclidean geometries (with its implications of non-intuitive curved spaces) is 3 Standard Stoppages of 1914. Duchamp describes the piece in a questionnaire from the Museum of Modern Art as “a joke about the meter – a humorous application of Riemann’s post Euclidean geometry which was devoid of straight lines” (Henderson, 61). As with all of Duchamp’s work, this art object functions on several different levels simultaneously.

The object itself consists of three pieces of wood cut to the pattern of a length of string which Duchamp claims to have dropped three times, so the resulting pattern is a random distortion of a straight line. Recent investigations of this crucial work also point out the nature of the French ‘stoppage’ or ‘invisible mending’ in relation to small alterations the artist made to the supposedly random shape. Most of Duchamp’s work contains an element of social parody or satire, and 3 Standard Stoppages is no exception. France at the time considered itself to be an arbiter of European High culture, and also acted as the official organ of the relatively recent metric system. By creating a new standard of measurement based on chance, Duchamp lampoons the French national pride in its standard measurement.

The Standard Stoppages also represent a major investment in the use of chance as an expressive medium (the piece is subtitled “Canned chance, 1914”). But there is a deeper element to the proclamation Duchamp makes with the Stoppages, which becomes manifest in the Large Glass. The Stoppages stand as the foundation of the fictional physical system that Duchamp describes in the notes of the Green Box, and diagrams in the Large Glass. He decisively breaks away from the classical, rationalist physical model and determines a new fundamental unit for his new science.

Duchamp refers to Jarry’s ideas and consciously speaks about his desire to re-invent the physical model of the time when he describes the Stoppages as “casting a pataphysical doubt on the concept of the straight line as being the shortest route from one point to another” (Henderson, 62). He states in his notes that he is interested in describing “a reality which would be possible by slightly distending the laws of physics and chemistry,” (Henderson, xix) and the original Stoppages represent a fundamental unit of that distension. Rather like Planck’s constant in quantum mechanics, or the speed of light in General Relativity, the Stoppages represent a new basic metric for describing and measuring the profoundly irrational space that is described in The Bride Stripped Bare by Her Bachelors, Even. This relationship is evident in the placement of a Network of Stoppages in the Large Glass, a pataphysical device that carries the spray of the Bachelor Machine to the sieves and parasols. He places the new metric directly into the system, using his measuring device to transport the erotic energy of the Bachelors.

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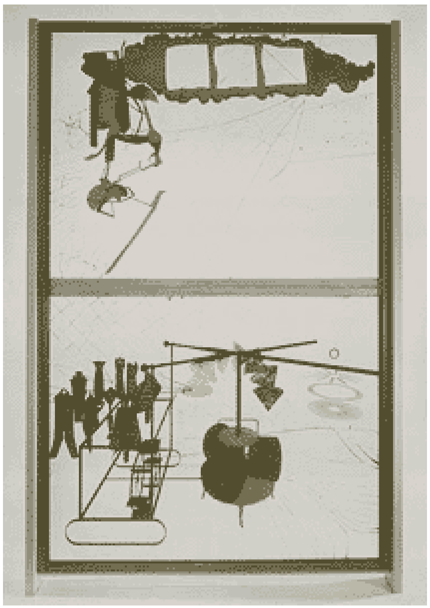

Figure 2
Marcel Duchamp, The *Bride Stripped Bare by her Bachelors, even (The Large Glass)*, 1915-23

The Bride Stripped Bare by Her Bachelors, Even is a modern day chimera, with almost as many interpretations as it has had viewers. In some sense, though, it can be called a pataphysical system that makes a "…critique of scientific laws and determinist causality" (Henderson, 185). Duchamp incorporates many different scientific ideas of his time into the workings of the piece, and had been exploring these ideas for some time. Beginning with the Cubists and their exploration of Bergsonian ideas of simultaneity, Duchamp also worked with the evolving notions of fourth dimensional space and X-ray exploration of previously hidden realities. His ideas of the experience of time went into his Nude Descending a Staircase, No. 2 in 1912. Although he started work in this vein under the auspices of the Cubists (including his

brothers, artists Jacques Villon and Raymond Duchamp-Villon) the execution of the Nude proved too radical for the Cubists, and Duchamp subsequently declared he was through with art "Movements." From there, Duchamp explores even further his ideas of 4th dimensional space in his series of studies of the Bride figure.
The Large Glass itself contains many interlocking mechanisms whose function appears to be to transform and transport the "illuminating gas" from the Bachelor Machine to the 4th dimensional realm of the Bride, where it is stored in a reservoir as "love gasoline" which the Bride uses to create her "cinematic blossoming." The Bride is a 4th dimensional being, at once an automobile, a wasp, a tree, a steam engine, etc., while the Bachelors consist of 9 "mallic moulds" which contain the invisible illuminating gas and function as 3-dimensional template shapes, analogous to the 2-dimensional negative's relationship to the photographic print. Duchamp at once mimics scientific description of these mechanical systems and parodies scientific understanding, which was thrusting itself on the Western consciousness in the form of massive industrialization and mechanization. Some of the imaginative physical processes described in the Green Box (the notes that accompany the Large Glass) include the stretching of the unit of length, the oscillating density, emancipated metal, and friction re-interpreted (Henderson, 192).

In positing this system, Duchamp seems to place his science in the context of irrational desire and exploration. It is as if he took standard physical systems, and substituted erotic lust as the prime motive force instead of gravity or momentum. Duchamp functions here almost as a Freudian physicist, attacking the conventional norms of the rational, determinist conventions of the time on multiple, multivalent levels. By inserting the irrational desires of the Freudian id into the newly forming non-deterministic physical models, he disarms and "unloads" classical positivist social, physical, and psychological ideas.

While certain elements of the coming revolution in particle physics were already in evidence at the time Duchamp was working on the Large Glass, the breakthrough work establishing a scientifically sound, physical basis for indeterminacy came in 1926 when Schrödinger published his famous equations unifying the particle/wave dualism observed in the behavior of certain particles. Establishing the basis for what is now field theory, Schrödinger's equations describe particles as discrete quanta of energy that exist as a statistical flux, or a range of possible positions or states. The implication of this model is that, under certain definable conditions, it may not be possible to predict exactly what these particles will do next. Furthermore, further quantum theories postulate that in a real sense these particles do not have precise positions during certain interactions until they crash into something that can be observed and measured.

By the time these postulates become established, classical Newtonian physics no longer seemed to apply to physics on the sub-atomic scale. In fact, it is only by a statistical summing over of these stochastic irregularities at a much larger scale that the classical Newtonian behaviors of everyday objects are explained. These formulations were highly controversial, and scientists like Einstein and even Schrödinger himself rejected them as too irrational and mysterious. This unmeasureability in particle physics has a direct antecedent in the work of Duchamp, particularly in his conception of the Bride in the Large Glass. He conceives of her as inhabiting a 4th-dimensional world above that of the Bachelors that is unmeasureable. The Bride herself is a 4th-dimensional being who cannot be measured in any conventional sense. In order to claim a common ideological ancestry of these concepts, there must be a common link that they share. To find that link, we may look to mathematician Henri Poincare, especially his outlook on scientific and mathematical descriptions of the world called conventionalism. Poincare's attitude toward the non-Euclidean geometries discussed above was that they were just as valid constructs for solving certain kinds of problems as the more traditional Euclidean descriptions that had been perceived to be eternal and unshakably true for over two centuries. He felt that scientific theories are only conventions used by scientists to describe the patterns they see in nature. This is a sharp contrast to the realist perspective that scientific laws have a real existence that supercedes their manifestation in nature, a classical determinist formulation.

This conventionalist attitude would, perhaps, have been necessary before Schrödinger could have formulated his theories as he did. The model of a sub-atomic component as both a wave and a particle is an imagined metaphor for what the interactions might look like if we were able to perceive them directly. But no such thing that is both a wave and a particle exists in our direct experience. To formulate such a model and work under the assumption that it is an accurate and useful depiction of the actual interaction presupposes that the author understands the model as being a convenient metaphor, an initial convention, not necessarily a discovery of the true laws of nature. We see the roots of conventionalism in Duchamp's pataphysics as well. His declaration of an intent to describe a reality formed by "slightly distending the laws of physics and chemistry" is a statement that he intends to explore a system with altered conventions. He understood the power of the imagined scientific metaphor and wished to apply it in his own artwork.

The next major piece of the indeterminacy puzzle arrived in 1927 with the publication of Heisenberg's uncertainty principle. Heisenberg had analyzed the implications of measuring the state of a particular particle. The only way to determine anything about the position or momentum of an object is to interact with it, to shine a light on it, or hit it with something else and measure how the second object reacts. But at the scale of the sub-atomic, "shining a light on it" is the same as hitting with something; at that scale, light interacts as a particle itself (called the photon) which has a definite mass and momentum of its own. If one wants to determine the position of an electron, one must hit it with something like a photon, measure how the photon's trajectory is altered by the collision, and deduce from the trajectory of the electron. The only catch is, there is nothing with which to hit the electron that is small enough not to perturb its initial trajectory. By the act of measuring the state of the electron, one must alter its initial trajectory. By this, Heisenberg deduced that one can never be certain of both the position and momentum of a sub-atomic particle such as the electron. In addition, because of the seemingly unpredictable implications of the particle/wave duality, the photon alters the trajectory of the electron in a statistically random way. This is quite an ontological blow to the Enlightenment doctrine that the world is inherently knowable; here we have convincing scientific evidence that there are some kinds of information which are physically impossible for us to gather.

In this way, Heisenberg contextualizes the scientific act of measurement. By considering the effect of the observer on the observed system, he changes the rules of science. No longer are we simply gatherers of knowledge that has an absolute existence in the world independent of us; we are active participants in a system that changes as a result of our interactions with it. Duchamp by this time had already been engaged in a similar enterprise aimed at the contextualization of the art world. His readymade works, such as Fountain, Bottle Rack and Bicycle Wheel, force the reconsideration of the nature of the art object. By discarding the accepted context of the perceived object, the artist forces the viewer to be an active participant in an experience Duchamp insists to be art. He believed that the art experience was one created not only by the artist, but also the spectator. In a speech to the American Federation of Artists in 1957 he said,

"… The creative act is not performed by the artist alone; the spectator brings the work in contact with the external world by deciphering and interpreting its inner qualifications and thus adds his (her) contribution to the creative act."

The forces that Duchamp explores in his work are invisible, obscured. His interest in x-rays, radio waves, and magnetism inform and give shape to his pataphysics, as they also define the trends in physical sciences discussed here. The psychoanalytic theories of Freud and Jung that were so terribly influential on European and American artists of the time emphasize the hidden aspects of the personality; the subconscious is that which cannot be known or experienced by us directly but has a substantial impact on our actions and who we believe ourselves to be. There was at the time a confluence of thought accepting the existence of hidden mysteries with the intent to explore their boundaries. Gabriel Buffet Picabia characterized the 1910s as a time of "an ebullience of invention, of exploration beyond the rational in every domain of the mind- science, psychology, imagination.… It would seem, moreover, that in every field, a principle direction of the 20th century was the attempt to capture the 'non-perceptible'"(Henderson, XX).
It is unlikely that Duchamp's work had any direct influence on the scientists working in the areas that I have described, but the current of thought that has been carried through in so many ways through so many different permutations has had a profound impact on how we view the world around us. The complexities of Marcel Duchamp's thought and the rich history behind the development of indeterminate quantum physics deserve far more attention than I have been able to give them here. It would be valuable to invest more attention into the roots of the Enlightenment ideals I have referred to, and to explore the reactions of the guardians of the Enlightenment ideals to early 20th century doubts. Further investigation of Duchamp's notion of "unloading" ideas from objects and systems that he explored in the readymades warrants further

investigation, to see the effect of his unloading in scientific gestalt of the era. The chaos mathematics that has become such a powerful way to investigate patterns in seemingly random behaviors may have some very interesting parallel ideas to some of those presented here. This essay only scratches the surface of many relevant topics. But the exercise of examining the ideas from the different disciplines I've touched on (art, science, and psychology) seems a very productive one, and the similarities and differences in the conceptions of the world help enrich our understanding of ourselves and how we have come to believe the things we believe.

Sources

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