IF THEN

If / Then: Measuring matter through metaphor; a poetic exploration of science

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abstract

This thesis investigates physical and philosophical measurement within the context of a Masters Degree in Visual Arts. By unpacking concepts within science through a philosophical approach to material, this study underscores and investigates questions of certainty and the unknown. This entails the examination of associated terms like ‘accuracy’ and ‘result,’ where such results are expressed and arrived at through chance and temperament rather than mathematical equations or formulas. Using the example of a Universal Conditional Statement, specifically (x)(Px⊃Qx), this physical / philosophical methodology will be applied to a practice-led artistic research. The given Statement simply denotes that what is on both the left and right of the symbol “⊃” are interchangeable, subject to the condition of “if… then”. This symbol is one that encapsulates and encompasses this document, which seeks to explore the relation between ‘if’ and ‘then’, as well as the known and unknown. Towards this end, and to understand, connect and manipulate through the measuring of material, aspects such as ‘Facts’, ‘Laws’ and ‘Quasiserial Arrangements’ are investigated.

In addition, through the study of a physical measuring tool, the metre, and the history of the metric system, this thesis also tracks and discloses information regarding the quest for accuracy, demonstrating how this ever-evolving objective goes hand in hand with inaccuracy, something especially apparent in the calculation of the immeasurable and the unknown. Part of this focus looks at Werner Heisenberg’s Uncertainty Principle, which reveals the hybrid and extravagant behaviour of material and also affirms that the result of an experiment is only as accurate as the domain in which it is set.

Concepts such as fact, uncertainty and material exploration are used by the artist in the creative process to test, measure and influence material. In this creative process, the body is sited as subject, as one that not only measures, but is measured against. When the body is added to a set of conditions, aimed to question material behaviour, the results prove unpredictable. Though material exploration and the appropriation of measuring through metaphor, the haptic and the tactile provides access and act as placeholders for the moments where material behaves in ways we cannot predict.

opsomming

Vir die studie tot 'n Meestersgraad in Visuele kunste, ondersoek hierdie tesis die fisiese en filosofiese aspekte van meetbaarheid as konsep. Die studie is geposisioneer binne 'n wetenskaplike filosofiese benadering tot materiaal. Binne hierdie raamwerk word oomblikke van 'sekerheid' beproef en die onbekende word geopenbaar. Dus, terme soos 'akkuraatheid' en 'resultate' word bevraagteken en getoets, asook hoe hierdie inligting geproduseer word deur oomblikke van 'kans' en 'temperament', eerder as wiskundige vergelykings of formules. As 'n methode vir artististiese navorsing word daar gebruik gemaak van 'n voorbeeld van 'n universele voorwaardelike verklaring soos; $(x)(Px \supset Qx)$, wat dan dien as 'n metafoor vir fisiese asook filosofiese kwessies vir meetbaarheid. Die gegewe stelling dui aan dat wat aan beide links en regs van die symbool ⊃ is, kan as verwissellende gegewes beskou word - onderhewig aan 'n voorwaarde soos; 'as … dan'. Hierdie simbool som hierdie navorsing op en mik om die verhouding tussen die 'as' en 'dan' te verken, asook die verhouding tussen dit wat bekend en wat onbekend is. Om materiaal te verken, deur die proses van meet en manipulasie, word aspekte soos 'feite', 'wette' en "quasiserial arrangements" ondersoek.

Deur die bestudering van 'n fisiese meetinstrument, naamlik die metre, asook die geskiedenis van die metrieke stelsel, wys hierdie tesis op die voortdurende soeke na meetbare akkuraatheid. Wat dit demonstreer, is hoe hierdie fisiese instrument 'n ewig-veranderende aspek saamdra, en is daarvolgens gekoppel aan onakkuraatheid. Dus, hierdie inligting word slegs weerpeel deur middel van - en is akkurraat volgens en is die instumente wat beskikbaar is. Die instrument bepaal die resultaat. Deel van hierdie ondersoek verwys ook terug na Werner Heisenberg se 'onsekerheidsbeginsel' wat die onbekende en buitensporige gedrag van materiaal tentoonstel, asook hoe dit bevestig dat die uitslag van 'n eksperiment sleg akkuraat is binne die konteks van die domein waarin dit afspeel.

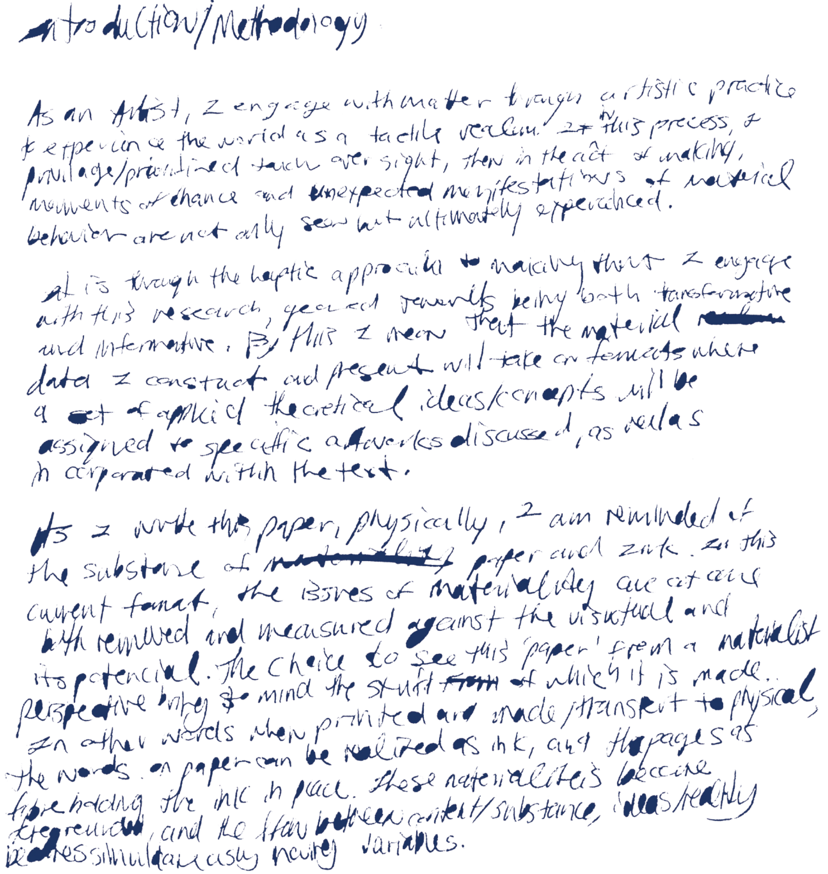
Konsepte soos 'feite', 'onsekerheid' en 'materiaal verkenning' word voortdurend deur die kunstenaar in sy kreatiewe proses getoets. Dit is juis in hierdie proses waar die meet en invloed van material 'n groot rol speel. Die kunstenaar benader die liggaam as 'n onderwerp wat meet en waarteen gemeet word. Wanneer die liggaam saam met 'n stel voorwaardes gevoeg word, word die gedrag van dit wat ondersoek word onbepaalbaar en word die onvoorspelbaarheid van material beklemtoon. Deur die aanwending van meet deur metafoor, vir die doeleinde vir 'materiaal verkenning', word die haptiese en die tasbare toegang tot material plekhouers vir die oomblikke waar materiaal onvoorspelbaar kan optree.

Matter is in itself not a reality but only a possibility,
a `potentia'; it exists only by means of form.

Werner Heisenberg, 1958 (Heisenberg, 1958:89).

sections

page



Introduction/Methodology

As an Artist, I engage with matter through artistic practice
I experience the world as a tactile realm. In this process, I
privilage/prioritized touch over sight, then in the act of making,
moments of chance and unexpected manifestations of material
behavior are not only seen but ultimately experienced.

It is through the haptic approach to making that I engage
with this research, geared towards being both transformative
and informative. By this I mean that the material
data I construct and present will take on formats where
a set of applied theoretical ideas/concepts will be
assigned to specific artworks discussed, as well as
incorporated within the text.

As I write this paper, physically, I am reminded of
the substance of paper and ink. In this
current format, the issues of materiality are at once
both removed and measured against the visual and
its potential. The choice to see this 'paper' from a materialist
perspective brings to mind the stuff of which it is made.
In other words when printed and made/transport to physical,
the words on paper can be realized as ink, and the pages as
fibre holding the ink in place. These materialities become
foregrounded, and the flow between content/substance, ideas/reality
becomes simultaneously moving variables.

Fig. 1 | Hand written introduction note

introduction/*methodology*

As an artist, I engage with matter through artistic practice to experience the world as a tactile realm. If, in this process, I privilege and prioritize touch over sight, then in the act of making, moments of chance and unexpected manifestations of material behaviour are not only seen but also ultimately experienced.

It is through the haptic approach to making that I engage with this research, geared towards being both transformative and informative. By this, I mean that the material data that I construct and present will take on formats where a set of applied theoretical ideas and concepts will be assigned to specific artworks discussed, as well as incorporated within the text.

As I write this thesis, digitally, I consider the now absent substance of paper and ink (see Fig.1) when writing it physically. In this current digital format, the issues of materiality are at once both removed and measured against the virtual and potential. The choice to see this research from a materialist perspective brings to mind the stuff of which it is made. In other words, when printed and made physical, words on paper can be realized as ink, and the pages, as fibre, hold this ink in place. When such materialities are foregrounded, there is a fluidity between content and surface, and ideas and reality; visually shown by both text and opposing blank pages.

It is my acute awareness of the material in my everyday observations that has enhanced a theoretical understanding, development and exploration of the motivation behind my art making process. This material appreciation of the surface - on which this text rests - relates to the content of the text and speaks to a parallel haptic and thought-based comprehension.

Through the lens of Philosophy of Science, and an investigation into the history and modes of measuring, I shall present information that informs my own research, both theoretical and practice-led. I will unpack concepts of measurement, observation and manipulation in order to understand the properties of material and its prosaic and philosophical behaviour. Measurement, both physical and philosophical, will be considered in relation to the human body; the body as the tool that not only measures, but is also that which is measured against. Pertaining to observation, I shall loosely demonstrate the difficulties embroiled in such a term/action as it relates to material, and how matter is affected by and changes in accordance with the body. Lastly, I will explore through manipulation and alteration, where I as the artist begin to experience material through adding, subtracting, creating tension and balance. Thus, by exploring materials through measuring, observing and manipulating, I will, through practice-led research, explore the philosophy of science as it informs this investigation. Pointing to my research question, can the body, specifically, masculinity be quantified through material exploration?

My focus, then, is to look at such systems of measuring, observing and manipulating, and to apply this information in unconventional expressions in combination with variables within my own work. Further, my aim for this investigation is to inform and heighten a physical awareness and understanding of various materials, as they allude to states of being and the body.

I aim to take scientific concepts and apply them poetically to my own work, as well as in the writing of this thesis, to aid my research question. In both the first and second section of the thesis, namely **e|t** and **uncertainty**, I outline and expand on foundational concepts and ideologies involved with measurement and scientific practices. Specifically, e|t presents an exploration of theories explored by Rudolf Carnap, a philosopher of science; associated with the Vienna Circle and Logical Positivism. Michael Friedman writes: “Throughout his philosophical career, Carnap places the foundations of logic and mathematics at the centre of his inquiries” (Friedman 1967). It is his *An Introduction to the Philosophy of Science*, where I as artist started my research and found Carnap’s exploration and explanations insightful and clear. However opposing theories of philosophers such as Thomas Kuhn and Karl Popper, contribute to the larger scope of analytic philosophy, to which Logical positivism is associated with. David Macey provides a brief explanation on analytic philosophy, from its historic perspective prior to and after the twentieth century, (from knowledge through experience and the senses) to how it has been tied to the English language:

> "Analytic philosophy can be seen in historical terms as an heir to the EMPIRICISM ... 'Analysis', that is, understood as meaning the reduction of complex ideas to their ultimate simple constituent ideas. Whereas the empiricists of the seventeenth and eighteenth centuries were attempting to establish a psychologistic EPISTEMOLOGY, the notion of 'analysis' is applied in the twentieth century to language and particularly propositions" (Macey 2000:13).

In conjunction to what I discuss in the e|t section, (under statistical law - that each result has merit) Macey writes regarding Logical Positivism: "in contention that philosophy has a curative or therapeutic function because what appear to be philosophical problems arise from the misuse or imprecise use of language" (Macey 2000:13). Logical positivists such as Carnap, according to Macey, "hold that problems of philosophy, especially metaphysics, are mostly problems that arise from language" (Macey 2000:13). In this thesis, I look at the language used by Carnap (*An Introduction to the Philosophy of Science)*, and respond to slippages in this scientific language, poetically through art making and presenting them as facts.

Awet Moges writes that Kuhn, as a gaint-slayer, "debunk[ed] several of the main theses of logical positivism" (Moges 2010). However, Macey reveals Khun's abandoned ideas regarding "history of science as a gradual and linear accumulation of knowledge" (Macey 2000:219) but sections referred to as periods of natural science. For Khun, and Carnap (to my mind), who place heavy focus on when and by whom scientific fact is presented; including the errors that contribute to the validity or the accuracy of such facts (Macey 2000:219). Moges states that many theorists such as John Earman, Michael Friedman and George Reisch, 'pointed out that Carnap's philosophy of science had much in common with Kuhn's normal science and paradigm concept' (Moges 2010). On the other hand, according to Stephen Thornton, "Popper holds that there is no unique methodology specific to science" (Thornton 2014). In *The Stanford Encyclopedia of Philosophy*, regarding Popper, Thornton writes that the "theory of demarcation is based upon his perception of the logical asymmetry which holds between verification and falsification", stating that it is not so much to prove the theory but to disprove it. He adds an example "if a single ferrous metal is unaffected by a magnetic field it cannot be the case that all ferrous metals are affected by magnetic fields" (Thornton 2014).

However, it is the explanations of Carnap that gives clear entry to scientific thought that is of interest to me. What I aim to find under terms such as fact and conditions that exist within science, is that it runs parallel in the practices within the arts. Each experiment starts with a unknown and a given, where the result is the interplay of these. Carnap begins his explanation by distinguishing between empirical and theoretical laws, hence the title of my first section, e | t.

As Carnap's thoughts do not diverge from empirical precision, I unpack and discuss (from *An Introduction to the Philosophy of Science*) the difficulty and problematic use of language which Carnap aims to clarify, when using words such as 'fact' and 'approximately' within the natural sciences. The definition and parameters regarding experiments need to be defined in order to retain accuracy, this is discussed in length in the e|t and metre section. In the search for accuracy, clarity is what Carnap highlights in this introduction to scientific thought; the very reasoning for turning to Carnap's *An Introduction to the Philosophy of Science*. Therefor as a guide to methodologies within natural science and scientific thought, I investigate and appropriate Carnap's facts, to my own methodologies and terms such as 'reflexive' and 'isomorphism' to my sculptural practice (through a poetic response to scientific thought); making sculpture as experiment. But, Carnap writes in his *Philosophy and Logical Syntax*, "[a] lyrical poem has no assertaional sense, no theoretical sense, it does not contain knowledge" (Prassas 2014), however, he contradicts this when he writes by way of an example in his *An Introduction to the Philosophy of Science,* when discussing symbols, "[symbols] merely state relations that hold between certain concepts, not because the world has such and such a structure, but only because those concepts are defined in certain ways (Carnap & Gardner 1995: 9).

Macey names other theorists within poststructuralism, within the Human Sciences, such as Derrida, Baudrillard, Delueze, Lyotard, Rorty and Bartes, whom according to Macey, as poststructuralists, are reluctant "to ground discourse in any theory of metaphysical origins" due to its plurality and its instability, to my mind, regarding language (Macey2000: 309).

The interplay between art and science is one that is picked up on in the following section, titled uncertainty, where philosopher of science Werner Hesienberg writes on the artist and compares the one with the other, "The artist tries by his work to make these features understandable, and in this attempt he is led to the forms of the style in which he works" (Heisenberg 1962:65-66). Perhaps meaning is not inherent but applied as Carnap would suggest, however, with both science and in art, is the testing of limits and the interplay; an experiment my thesis highly encourages.

The second section entails a brief overview of Werner Heisenberg's Uncertainty principle, followed by experiments that aim to contextualize its original and contemporary effects on material. This section, uncertainty, is not on Heisenberg, but the Uncertainty principle; focusing on the effect of observation as it relates to material behaviour and the unexpected. The aim of this section is to look at a scientific extension of what Carnap writes regarding theoretical law, and therefor acts as example of thereof. Mathematical physicist Harrie Massey summarises the uncertainty principle, in *The New Age in Physics* (1960), which I included to contribute to the reading of an experiment by Olaf Nairz, Markus Arndt and Anton Zeilinger, (Nairz, Arndt & Zeilinger 2001). My aim is to provide context to Carnap's theoretical law and provide data as it conceptually links to the practical approaches in my sculptural practice, where uncertainty takes centre stage.

After these two sections, I investigate the metric system; both its historical context as well as its functionality as a physical measuring tool. As an introduction to this section, I inserted a line equal to an exact metre, which spans over eight pages. In **the metre** section, I look at how this device has developed since its conception in 1670, crediting Gabriel Mouton. As Mouton suggested, measurement should be derived "from the physical universe [as opposed to] the human body" (Hopkins 1975:10). It is from this perspective that I investigate the metric system as opposed to the Imperial. I choose the metric system as it relates to the quest for certainty over the unknown, evident in the metre's development in the 'age of progress'

(Hopkins 1975:13). In an artwork where I reflect on this section, I have marked an exact metre on my body by way of a tattoo, which is discussed in the **me+** section. In doing so, my body becomes the physical device that aims to measure accuracy, apposing yet still meeting the criteria set by Mouton.

In addition to this, the metre section comprises of two more subsections, one in which measurement and experiments as they relate to accuracy and inaccuracy is discussed. The last, returns once more to Rudolf Carnap, with focus on a comparative method of measurement. This particular section is of great interest to me, as it is the physical manifestation of the thesis, which exists as both a written component(book) and a wooden component, cut to the exact size of its counterpart.

In the final section titled me+, a series of physical experiments derived from exploring systems of measurement are discussed, revealing the poetic potential of these scientific philosophies in my work; placing my body central to a series of variables.

ONE OF THE most import distinctions between two types of laws in science is the distinction between what may be called (there is no generally accepted terminology for them) empirical laws and theoretical laws

Rudolf Carnap, 1995 (Carnap 1995:225).

e | t

Rudolf Carnap was a German-born philosopher, who was active in Europe and in the United States, and was a member of the Vienna Circle and a proponent of the philosophy of Logical Positivism (Schillipp 1963:20)(Wilson 2007:70).[1] In the *Routledge Critical Thinkers* series, on *Theodor Adorno*, Ross Wilson sheds light on positivism. Here Wilson not only summarizes but also contextualizes this movement of philosophy stating that, "'positivism' is the main characteristic of twentieth-century 'analytic philosophy', in which metaphysics is eliminated along with all other non-verifiable and hence meaningless – on this view – areas of thought" (Wilson 2007:70).

However, Wilson continues to contextualize this particular movement, by introducing Karl Popper whose thoughts conflicted with Carnap, favouring empirical falsification. Wilson writes: "The sociologist and philosopher of science Karl Popper (1902–94) advanced the view that 'The method of the social sciences, like that of the natural sciences, consists in trying out tentative solutions to certain problems'" (Wilson 2007:70). This particular point regarding merit, within both the social sciences and natural sciences, is what this thesis aims to make clear and reveal how the one influences the another.

I have chosen the teachings of Rudolf Carnap, and the philosophy of science, as outlined in the text *An Introduction to the Philosophy of Science* (1953), as an entry point into this subject and the methodologies that are practiced in this field.[2] As an artist interested in science, I look at his introduction to science; discussions on empirical and theoretical laws and how these laws pertain to measurement; through which I apply poetically to my art-making process. Carnap begins distinguishes between Empirical and Theoretical, hence the section title, e | t.

Universal Law

Carnap unpacks and expands on the formation of and expressions around regularities in experiment observation. He distinguishes between different kinds

of statements, referring to them as either "statistical" or "universal laws"; both of which pertain to empirical and theoretical law. As a means to explain these terms, Carnap begins with the assertion: "All ice is cold" (Carnap & Gardner 1995:3). This statement is an example of what Carnap refers to as a universal law, which asserts that any piece of ice, at any place in the universe, at any time, be it past, present or future, is, was, or will be, cold. In other words, for a universal law to stand, information regarding an observation has to be plausible at all times and all places.

Carnap further states that: "The laws of science are nothing more than statements expressing these regularities as precisely as possible" (Carnap & Gardner 1995:3). Such statements are used to ensure accurate and concrete representational data in order to reflect plausible knowledge. Thus, while universal law expresses information that is seemingly consistent and unwavering, Carnap appears to simultaneously emphasize that these regularities can only be represented as far as our means of doing so allows - hence his use of the words "as precisely as possible" (Carnap & Gardner 1995:3). This touches on the formative power of language, which will be unpacked at a later stage.

Statistical Law

According to Carnap, not all cases fall under the umbrella term of universal law but, rather, are expressed in the form of what he describes as 'statistical law.' Carnap writes: "Not all laws of science are universal. Instead of asserting that a regularity occurs in all cases, some laws assert that it occurs in only a certain percentage of cases" (Carnap & Gardner 1995:3). That is to say, if the percentage is specified or if a quantitative statement is made about the relation of one event to another, the statement is then understood as a statistical law. To explain statistical law, Carnap provides the following two statements: "Ripe Apples are usually red" and "Approximately half the children born each year are boys" (Carnap & Gardner 1995:3). While these statements may be valid in many instances, they are not universal as the data is expressed in percentages and is applied when used to predict or approximate. To reiterate, statistical law revolves around forecasting data where statistics and percentages govern the credibility or validity of the data. In addition to the above two statements, Carnap further asserts that, "[e]ven

when statistical law provides only an extremely weak explanation, it is still an explanation" (Carnap & Gardner 1995:8). As an example, he states that under statistical medical law, five percent of people who eat a certain food develop symptoms. A patient could ask if he/she fall under that percentage. The doctor can then state that in ninety seven percent of the cases in which people have eaten that particular food, they have developed such symptoms. Carnap concludes: "Whether weak or strong, these are genuine explanations" (Carnap & Gardner 1995:8). This example reveals how statistical law is used when predictions are made and that such statements, generated through statistical research, can still be appreciated as valid.

As statistical law is premised on estimation or approximation, it leaves room for error and reasonable doubt. In addition to this inference, in my opinion, Carnap's examples of apple coloration, annual birth statistics and statistical medical law further demonstrate questionable credibility when using words such as "usually", "approximately" and "weak" in the examples mentioned above, (Carnap & Gardner 1995:8). This problematic linguistic propensity, and the dependence thereon of such statements, as expressed in Carnap's examples, is an extension of what will be discussed in relation to the term 'fact' as the section progresses. However, although the indiscriminate use of language is not fully acknowledged in this instance, I do acknowledge that these examples still have merit. Carnap's examples, although seemingly trivial, are also revealing of fact; fact that has been deduced through investigation and rigorous testing, even though the statistical field in which they are framed makes allowance for partially incomprehensive or unverifiable results. It is these gaps between knowing and not knowing, between universal and statistical, that are of interest to me. Around these investigations, the study and mapping of concrete data and its variables reveal gaps and fissures. It is these fissures (linguistic and scientific) that I find to be of significance. Each experiment reveals the impossibilities of measuring and substantiating accurately. Employing the combined data, it is the space between that created an approximated accuracy.

Universal Conditional Statement

Carnap expands on universal and statistical law with a basic "Universal

Conditional Statement" as the logical form and expression for these laws, stating that "this universal conditional statement is the basic logical form of all universal laws" (Carnap & Gardner 1995:4). Such an equation for this universal conditional statement reads as follows:

$$(x)(Px \supset Qx)$$

This conditional statement simply indicates that the symbols P and Q are linked and both share (x). The ⊃ is a connective symbol linking the two variables it is put in relation to. In English, it corresponds roughly to the assertation "If . . . then . . ." (Carnap & Gardner 1995:4). 'x', also known as a Universal Quantifier, could be any material body and, in this conditional statement, has the properties P and Q. Carnap claims, "not only does Qx hold whenever Px holds, but the reverse is also true; whenever Qx holds, Px holds also" (Carnap & Gardner 1995:4). In such cases, the term "biconditional" can be applied, simply stating that the condition can go both ways (Carnap & Gardner 1995:4).[3] In my opinion, as an extension of Carnap's example, I consider that in this conditional statement, when one symbol (which represents an action) is substantiated, so too will the other, due to the conditions of the statement. That is, in my own words, if material is the subject of my study, then, surely, the product of this investigation would take a material form. At least, one that is of an alternate form (that exists in conjunction with) to intelligible words resting on a page. I take this universal conditional statement, highlighted by Carnap, as a metaphor for my own practice; a point that will be expanded on as my argument progresses.

To reiterate, Carnap identifies universal and statistical laws, in which universal conditional statements are used to express these laws. In the case of universal law, Carnap states that: "In Physics, of course, one tries to obtain quantitative laws and to qualify them so as to exclude exceptions; but if we forget about such refinements, then this universal conditional statement is the basic logical form of all universal laws" (Carnap & Gardner 1995:4). In contrast to Carnap's examples of universal laws (e.g. "all ice is cold"), he introduces the 'singular statement.' Carnap provides the following example to distinguish and point out the confusion around universal law and a singular statement: "Yesterday in Brazil, Professor Smith discovered a new species of butterfly" (Carnap & Gardner 1995:4). This statement reveals data of a single time and place, therefore Carnap

states it cannot be an example of a universal law. It is thus a singular occurrence and is, consequently, a singular statement. As substantiated by Carnap, "[b]ecause statements such as this are about single facts, they are called singular statements" (Carnap & Gardner 1995:4). He continues to stress that knowledge is inherent to and produced through such singular statements as much as it is by universal laws (Carnap & Gardner 1995:4). Indeed, in my opinion, such singular statements are of merit and are not to be discounted. Carnap further states that, in his opinion, the fact and law dynamic is a central concern in the field of philosophy of science (Carnap & Gardner 1995:4). Namely, that these singular statements have the potential to become universal law. Singular statements, both in themselves and as that which can feasibly become universal law, are of importance to my own investigation and measurements. For instance, bending steel, marking my body, crying into cement, and so on.

In distinguishing knowledge as singular or universal, Carnap alludes to language and the misuse of certain terminology, such as the word 'fact.' Carnap states: "The word 'fact' was originally applied (and we shall apply it exclusively in this sense) to singular, particular occurrences" (Carnap & Gardner 1995:5). As an example, Carnap refers to a zoologist who makes the statement: "The Elephant is an excellent swimmer" (Carnap & Gardner 1995:5). This statement is not a singular statement, as the zoologist uses 'the' in what Carnap maintains to be the "Aristotelian sense" (Carnap & Gardner 1995:5). That is to say, the zoologist is referring to the entire species of elephant, and not an individual. However, this statement becomes problematic, as the distinction that defines it as singular or universal is unclear, thereby creating confusion. This statement, presented as 'fact,' which Carnap claims can only apply to singular statements, has the potential to be misunderstood Carnap & Gardner 1995:5). Thus, the use of the term 'fact' in this instance can arguably be labelled as 'ill-considered.' In order to render such misleading statements as 'fact', clear labelling information, or some form of accompanying contextual information that can be used as a means to substantiate such claims (for instance), would need to be provided.

To summarize, before expanding on 'fact', universal law, as Carnap states, is conditional and must adhere at all times and all places for experimental data

to stand as 'universal'. Statistical Law is based on figures that provide and expand on experimental data with the aim to refine a study when results display specific and relational percentages, and can thus be used to predict results. Further, in relation to these laws, a universal conditional statement - in this instance (x) (Px⊃Qx) - as an expression for both singular statements as well as universal laws, has been and will further be considered. To briefly expand on this statement, this particular 'universal conditional statement' describes all cases pertaining to what the universal quantifier (x) is put in condition to - the limitations that test or support the parameters of the quantifier. Finally, it has been expressed that singular statements, or 'facts,' are of importance and are as weighty as the knowledge innate to and created through universal law. This is not only to the field of science but also potentially to art making processes.

Fact

As indicated, Carnap asserts that the term 'fact' becomes problematic due to confusion around its use, partly because its meaning changes respective to the discourse through which it is framed. For instance, according to Carnap, its use within philosophy and within science differs significantly, where in the latter field it is often used too casually or indiscriminately. Specifically, in the sciences, the word 'fact' relates only to a singular condition. That is, to recall a previous claim made by Carnap: 'the word 'fact' was originally applied (and we shall apply it exclusively in this sense) to singular, particular occurrences' (Carnap & Gardner 1995:5). As shown, Carnap demonstrates this misuse of the term 'fact' by way of an example - specifically, the statement: "The Elephant is an excellent swimmer" - which he reveals to be misleading and untenable (Carnap & Gardner 1995:5).

Carnap's questioning of the word 'fact' and the confusion around and flippant use of this term appears, in my opinion, to extend beyond his example and to language in general. That is, language seemingly acts a barrier that misrepresents or limits information. To substantiate my claim, I refer back to Carnap's discussion on universal and statistical Laws. Namely, regarding universal law, where Carnap states that: "The laws of science are nothing more than statements expressing these regularities as precisely as possible" (Carnap & Gardner 1995:3). As

already stated, the aim of science, by means of vigorous testing, is to accurately reflect what is perceived, observed and witnessed in order to make sense and to create consensual knowledge. Again, Carnap's statement, to me, unquestionably demonstrates that while universal law articulates information that is seemingly absolute, such regularities can only be represented as far as our means of doing so allows, "as precisely as possible" (Carnap & Gardner 1995:3). Similarly, it has been suggested with regards to statistical law where, considering the examples of apple coloration, annual birth statistics and medical statistical law, Carnap's use of the words 'usually,' 'approximately' and 'weak' display somewhat questionable empirical evidence. I emphatically acknowledge that such examples have merit, however trivial they may appear. They demonstrate 'fact' and are as important as the knowledge that is intrinsic to and produced though universal laws. Further, I also recognize that the statistical field in which they are framed allows for (and fundamentally precipitates) somewhat incomprehensive or unverifiable results.

However, this is not to state that my inflections on the problematic nature of language are necessarily to be taken as solely negative. In this misuse, confusion or limitation, I also feel that one opens up possibilities for creative error or chance; something I actively explore and observe in my own practice.[4] Moreover, I also realize that the problematic language structures I highlight refer to but one 'type' of language. This assertion shall be revisited and expanded on in the ensuing discussion of symbolic logic.

Following the discussion of statistical law, Carnap introduces 'logical laws' and 'symbolic logic' (Carnap & Gardner 1995: 9); specifically, symbolic logic as an expression of universal conditional statements, which is explained in the following scenario. Carnap brings forth a scenario of simple logical laws:

If p and q, then p
If p, then p or q

The universal conditional statement referred to earlier, $(x)(Px \supset Qx)$, is another example of symbolic logic. Regarding the scenario mentioned above, Carnap writes:

> Those statements cannot be contested because their truth is based on the meanings of the terms involved …they tell us nothing whatever about the world. They merely state relations that hold between certain concepts, not because the world has such and such a structure, but only because those concepts are defined in certain ways (Carnap & Gardner 1995: 9).

In other words, the symbols comprising these logical laws (for example, logical law 1 and 2) are merely that - symbols. They have no meaning other than that which we assign to them and it is this application of information that makes and gives meaning or value to these statements.

Extending this discussion by way of another example, Carnap continues to emphasize and explore the term ‘fact’ as expressed through symbolic language and used in equations. Specifically, Carnap builds on and unpacks the notion of “definition”, explaining that: “we have precisely specified the meanings of ‘1’, ‘3’, ‘4’, ‘+’, and ‘=’, the truth of the law ‘1 + 3 = 4’ follows directly from these meanings” (Carnap & Gardner 1995:10). In my opinion, this statement seemingly demonstrates that the equation “1 + 3 = 4” exists and is understood on the basis that there is consensus on what “1”, “+”, “3”, “=” and “4” are defined as. Thus, while laws rest on repeated observations that aim to provide accurate information pertaining to what is in question, they also seem to rely on a consensus on the definitions or terms involved.

It has already been expressed (firstly by way of Carnap’s example relating to ‘fact,’ and, by extension, my application of this reading to universal and statistical law) that language has the ability to misrepresent, limit, confuse, and even change information. Symbolic logic (for instance, a universal conditional statement), dependent on consensus on the meaning of the definitions and terms involved, is seemingly as problematic. However, could it not rather be stated that it is the assignment of meaning, through language, to symbolic logic wherein problems arise? As stated by Carnap, symbolic logic “[tells] us nothing whatever about the world. [It] merely [states] relations that hold between certain concepts” (Carnap & Gardner 1995: 9). In other words, we apply meaning and that meaning is

not inherent. An example of such an application would be Isomorphism, which Carnap suggests is performed when learning how to count, (as explored in the forth section, The Metre) (Carnap & Gardner 1995:60).[5] This is indeed the very problem with which I am grappling. When applying these concepts to this thesis, I am aware of the gaps between, the use of language and the representation of 'facts'.[6] In relation to the universal conditional statement, if material is the subject of my investigation, then the use of language has the potential to hold and present, to contradict and negate, the very nature of this investigation. It is at this point that the physical shape of the thesis, the materiality of the page, the ink on paper, can act as an 'actual' substitute for the content inherent to these words. Here, the wooden component of this thesis is centralized and regarded with equal importance to its textual counterpart (Herein I reflect on the writings of Tim Ingold and his thoughts on material and materiality).[7]

In addition, Carnap's discussion on symbolic logic also, in my opinion, suggests that what is called into question rests on the definition and parameters set by the conductor of the experiment. In other words, the conductor, who frames this experiment, is a crucial constituent to the experiment and its results as shown, "Assume that (1') is known..." (Carnap & Gardner 1995: 38) and "A scientist might say: "Yesterday in Brazil" (Carnap & Gardner 1995: 4). I relate this observation to my own practice where, briefly, I as the artist, take on the role of researcher and scientist who sets up experiments which calculate chance, balance and frequency. In particular, I investigate empirical data: that which is directly observable. This data is then applied to theoretical knowledge. This will become evident in the section where I disclose my own art-making practice, which brings into focus questions around the body, measurement and the conflations between them.

Returning back to the start of this section and its aim, I mean to explore the difference between 'empirical' and 'theoretical' law. The focus thus far has been on Carnap's explanation of the 'empirical' as the directly observable and measurable (for example, through simple tools like a ruler) (Carnap & Gardner 1995:226). The 'theoretical' on the other hand is where the immeasurable is brought into question and deduced by using that which is measurable.

This is then adapted or altered in order to describe what Carnap refers to as 'theoretical law'. However, Carnap makes it clear that: "The laws of logic and pure mathematics, by their very nature, cannot be used as a basis for scientific explanation because they tell us nothing that distinguishes the actual world from some other possible world" (Carnap and Gardner 1995:11). Thus, theoretical law, while valid, is not enough to substantiate concrete data; it must be supported by or framed through the empirical. Further, in my opinion, picking up on what was pointed out in the previous paragraph, it must be made clear that when choosing to say, for instance, an apple is (a), there needs to be context to what is being defined and for what (a) is being defined. Ultimately, a set of conditions and parameters need be adhered to when undertaking any experiment.

Before further illustrating the relationship between the empirical and the theoretical, I would like to revisit a claim made earlier. Namely, that singular statements, when repeated and vigorously tested and consistently verified at all times and all places, have the potential to become universal law. This statement suggests that if the set of conditions remain consistent, the validity of an experiment attains a higher merit over speculation. Linking this inference to universal law, Carnap states that universal law uses what is known to define and make sense of that which is unknown. To invoke Carnap directly: "When the law is universal, then elementary deductive logic is involved in inferring unknown facts" (Carnap & Gardner 1995:18). Thus, it can be deduced that by calculating through speculation, a series of experiments (however singular) could reveal direct results that could be measured and, if tested and proven consistently, potentially be expressed through a universal conditional statement and accepted as universal law. On the other hand, could this deductive logic of which Carnap speaks, developed through repetitive acts of measuring, then build a means of measuring through intuition, without any devices and making use of the body, using this 'deductive logic'?

As stated, according to Carnap, empirical and theoretical law refers to that which is measurable (or seen) and that which is immeasurable (or unseen). As an example, Carnap asks if the term 'molecule' exists as the result of an observation or if it stems from a speculation. This can be seen in the following section, where the

hypothesis of applying Heisenberg's theory of Uncertainty, applicable to the subatomic, tests the limits within an experiment, on larger objects than that of the subatomic. What Carnap is alluding to is how hypothetical theories (theoretical laws) use empirical knowledge (which is altered, shaped or manipulated) in order to be described or substantiated. Carnap further writes: "Regardless of whether the derived empirical laws are known or confirmed, or whether they are new laws confirmed by new observations, the confirmation of such derived laws provide indirect confirmation of the theoretical law" (Carnap and Gardner 1995:230). In other words, theoretical laws also have the capacity to derive new knowledge in the very investigation of the empirical employed to substantiate their authority.

As another instance of theoretical law, I revisit (p23) what was expressed earlier regarding the "precisely specified meanings" (Carnap & Gardner 1995:10) that we denote to, for instance, "1", "+", "3", "=" and "4". As explained, this example demonstrates that meaning is assigned to such terms and that this meaning is consensual. What this example also reveals, in my opinion, is that deductive logic is applied, through manipulating the values ascribed to these definitions axiomatically, to unveil what is unknown, by using known definitions to do so.[8] In other words, when the definition and given meaning of a term / symbol is understood, we can, ascribing to certain rules, recognize the term / symbol and even manipulate it in a variety of contexts and uncover what is unknown or unseen. That is, in recognizing and knowing "1 + 3", we are able to deduce that (if attempting to balance an equation) "1 + 3 = 4". Further, instead of saying "1 + 3 = 4", we might say "3 + 1 = 4" or "4 = 1 + 3", knowing that such symbols, although formulated differently, denote the same thing.

Conclusion

My interest as it relates to Carnap's ideas on empirical and theoretical law lies in the investigation of the measurability of objects and materials, to which I apply Carnap's basic universal and statistical laws; specifically the universal conditional statement. In addition, an 'experiment' as a philosophy is what, to me, alludes to a temperament and respect toward the reading and applying of the facts involved with and around an experiment. In my own work, I create my own set of facts

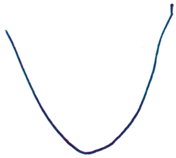
and experiments that reveal traces of testing and measuring my body. For example, experimenting with my physical being as the tool that simultaneously measures my strength when bending metal, and also the relationship with the material I test my body against. The resistant behaviour of the material and the force my body exerts over it, changes the state(s) of the material into one that reveals a Faktura trace or gesture in its material alteration.[9] Linguistically speaking, this then alludes to the use of figures of speech, using elements such as the metonym and metaphor as means to stand in or provide reflection as alluded to earlier in the thesis. It is in this action/study that the given and the variable are played out, thereby unpacking the known to reveal the unknown. This is discussed and practiced in the section titled me+.

Werner Heisenberg's 'uncertainty principle' will follow next as a continued investigation into this concept. As a contemporary of Carnap, and working in Germany, his theories are essential to the understanding of quantum physics and the subatomic behaviour of matter. My investigation will look at the work of Heisenberg pertaining to the theoretical law that Carnap discusses; where the empirical is manipulated in order to substantiate that which is hypothetical and speculative. Briefly, this principle examines the unpredictability of measuring the simultaneous position of a particle while in motion, and vice-versa. Heisenberg asserts, with regards to this principle, that the result of an experiment can only be expressed by and through what is tested. As David Lindley's writing encapsulates in his introduction to Heisenberg's book, *Physics and Philosophy* (2007):

> A quantum object, in itself, is neither one thing nor the other. If you decide to measure a wave-like property (wavelength, for instance, in a diffraction or interference experiment), the thing that you are observing will look like a wave. Measure a particle property, (position and velocity), on the other hand, and you will see particle behaviour" (Lindley 2007:XI).

uncertainty

In this section, I will be looking at Werner Heisenberg's theory through an example by Olaf Nairz, Markus Arndt and Anton Zeilinger; *Experimental verification of the Heisenberg uncertainty principle for hot fullerene molecules*, (Nairz, Arndt & Zeilinger 2001). This test investigates the limits of the microscopic threshold between the seen and the unseen, which both as an example and a concept relates to my pracrice, where chance and the unexpected are revealed (explored in section titled me+). Added to this section is writing from Harrie Massey and my own drawings, based on illustrations that aim to demonstrate Heisneberg's theory. This section is but a brief unpacking of Heisenberg's uncertainty principle, concerning material behavior, which is something I allude to, apply and reflect on in later by way of art making. This example of a Theoretical Law follows from the previous section e|t as data to and through which I respond poetically.



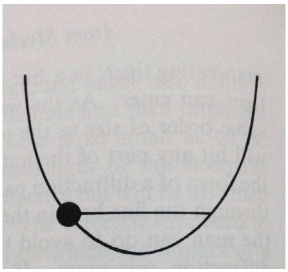
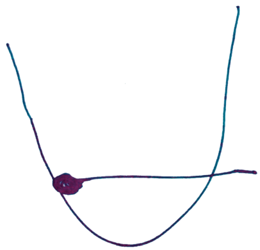
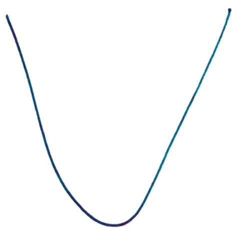
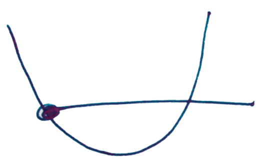


Fig. 2.1| Bowl Example
(Massey 1960:60)



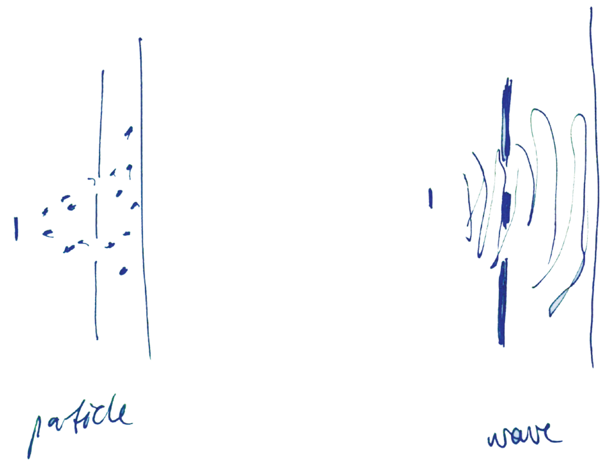




This study of atoms and matter through the quantum mechanic lens reveals and simultaneously blurs the exactitude of atomic/particle behavior. Heisenberg's uncertainty principle makes this especially clear. This principle is a study that looks at matter by means of microscopic and magnified observation, revealing unpredictable results. The aim of these studies is to record and observe the behavior of molecules and atoms, pertaining to material performance. The inexactitude revealed by the uncertainty principle is that the indeterminacy on both the position and velocity of a particle cannot be known at the same time. However, the obscurities pertaining to the quantum effects upon and within such experiments (the aim of which is to reach accuracy pertaining to universal laws, as explained by Carnap) have the potential to reveal the opposite. This unexpected behavior is understood through Heisenberg's theory which relates to both the seen and the unseen mode of material matter.

In *The New Age in Physics* (1960), mathematical physicist Harrie Massey, makes two important statements regarding Heisenberg. Firstly, "Heisenberg in 1927 first expressed these [particle position and particle momentum] limitations in terms of an uncertainty principle" and secondly, "the position and the momentum of a particle [cannot] simultaneously [exist] to any desired precision" Massey 1960:59). Here, Massey makes note of what the uncertainty relation is pared down to; namely, that there exists a relationship between testing the position and the movement of what is tested (be it a particle, wave or quantum object). In addition, regarding this relationship, what I understand Massey to suggest is that both the manner in which measurements are made, as well as tools used to make these measurements are of importance. In relation to this claim, which I expand on for the purposes of this article, I find the following quote to be of use: "[T]his [desired precision] is not possible, no matter how perfect the instrument used may be" (Massey 1960:59). Thus, in finding the momentum of a particle, "we must sacrifice all knowledge of its position and vice versa" (Massey 1960:60).

By way of an example, he provides fig. 2.1 to explain the uncertainty principle (Massey 1960:60). In addition, to fig.2.1, I have added drawing derrived from this exmaple. Massey states that according to the uncertainty principle, the


particle
wave

particle can never rest at the bottom of the bowl. This will suggest that the position and the momentum would simultaneously be known. Thus, to continue with the bowl example, the particle has to consistently move to comply with the relation (symbolic logic /equation) formula of the uncertainty principle: [$\Delta x \Delta p = h$].

In the next section, leading from Massey's means to express Heisenberg's uncertainty principal, the following illustrations aim to reveal an experiment pertaining to the behavior of matter (such as particles, waves and quantum objects, tested through what is called wave-particle duality) (Toutestquantique.fr, 2014)[10]. The following diagrams show individual tests of a particle, a wave and then a quantum object, respectively (see list of figures and additional data).

Fig. 2.2 | Particle drawing
Fig. 2.3 | Wave drawing
Fig. 2.4 | Quantum object drawing

These figures above (are drawings interpreted by the renderings discussed and can be found under additional data number 1,2 and 3), which showcase when the position through which particles, waves and quantum objects pass, is known, it is near impossible to determine the final position. These illustrations, providing a visual application of the uncertainty principle, are then taken a step further in the following experiment. What is tested in the following example is the effect of this principle as it relates to the larger realm of the seen or the directly measurable (empirical data).

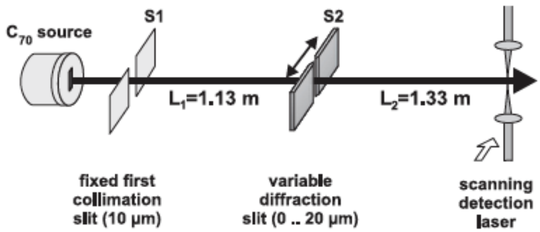
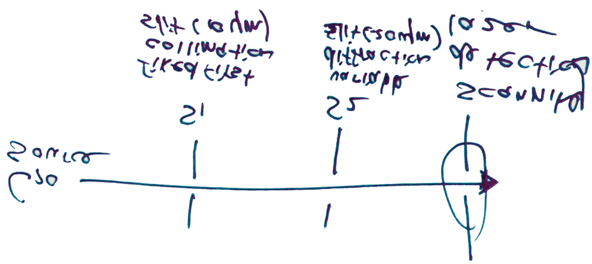


Fig. 2.5 | Fullerene molecule visual diagram
(Nairz, Arndt & Anton Zeilinger 2001:1).



Experiment

An experiment was conducted in May 2001 by Olaf Nairz, Markus Arndt and Anton Zeilinger, from the Universität Wien, Institut für Experimentalphysik, Boltzmanngasse 5, A-1090 in Wien Austria.

The Fig. 2.5, extracted from the experiment report, provides a visual diagram, exploring material behaviour similar to the figures provided earlier, such as wave-particle duality, accompanied by my own rendering of this material behaviour (ink on paper). This report however, reveals “a demonstration of the Heisenberg uncertainty principle using the most massive, complex and hottest single object so far, the fullerene molecule C70 at a temperature of 900 K” (Nairz, Arndt & Zeilinger 2001:1).[11&12]

This attempt to test Heisenberg’s uncertainty principle and the effect it has on larger objects could influence our means of perceiving information, possibly without the use of additional devices, such as the microscope. As further explained in the report: “There are good reasons to believe that complementarity and the uncertainty relation will hold for all sufficiently well isolated objects of the physical world and that these quantum properties are generally only hidden by technical noise for larger objects” (Nairz, Arndt & Zeilinger 2001:1).

These Scientists express that, “[i]t is therefore a matter of definition and convenience which quantities to take as a measure of the position and momentum uncertainty in our case” (Nairz, Arndt & Zeilinger 2001:1). What is suggested here, relating back to Carnap, is the level of control which resides with the conductor, as a director/guide of the experiment. Clearly indicating that the individual conducting the experiment sets the domain or rather the set of conditions, therefore influencing the outcome of the experiment, and, consequently, influencing the result/reading.

As a result of this investigation of measuring variable parts in motion, this experiment serves to prove the point again that the uncertainty principle, performed on such a large molecule, is found to be evident not just within the

microscopic and the subatomic realm, but regarding larger objects as well. As concluded in the experiment report, “[w]e regard the good quantitative agreement between the data points and the predicted curve as a good support for the validity of the Heisenberg uncertainty principle...” (Nairz, Arndt & Zeilinger 2001:4) In my opinion, however, despite this claim to accuracy, I also consider this example to be revealing of the interplay between accuracy and inaccuracy, due to the statistical grounds on which they validate their claim. Further, reiterating what was deduced earlier in relation to Massey, the unknown variability of what is tested, resulting from the inconsistencies of temperament and the devices used, must also be taken into account.

Conclusion

Heisenberg writes on art and the multiple styles as it relates to the concepts within science: “The artist tries by his work to make these features understandable, and in this attempt he is led to the forms of the style in which he works“ and “Therefore the two processes, that of science and that of art, are not very different” (Heisenberg 1962:65-66).

What Heisenberg is alluding to, is that the nature of things, the ‘material behaviour’, is made visible through the questioning of matter and the objects we are surrounded by. The expression or the interpretations of such instances, in art, take on many forms, when seen through the lens of artistic practice. Where within the sciences, the role of experiments is geared toward measuring and reaching accuracy. However, as with the particle-wave interpretation, science and art, experiment/artwork, sits between parameters which defines its reading. But as the uncertainty principle makes clear is that the reading of material and its behaviour reveals unpredictable results as stated by Massey, therefore suggesting that the terms involved are but variables that are potentially revealed through bending steel and crying into cement, that accuracy goes hand in hand with inaccuracy; that there is a level of uncertainty involved when measuring certainty. What Heisenberg is alluding to, to my mind, is that there is a blurring of the fields between scientist and artist; the manner in which both express data is influenced by “...the forms of the style in which he works” (Heisenberg 1962:65-66).

Fig. 3.1 | A metre line

the metre

To expand on the notion of measurement, I will be looking at the origin and development of the metre, and the metric system. By doing so, I would like to provide historical context to its conception as well as the resultant implications for everyday objects that are created and informed by this device. After unpacking the origin of the metre, I will look at the writings of H. J. J. Braddick, Sir Alan Cook and M. C. England that describe measurement as it pertains to the sciences, geared towards precision and accuracy. Finally, in this section, I also explore comparative measurement, making reference once again to Rudolf Carnap.

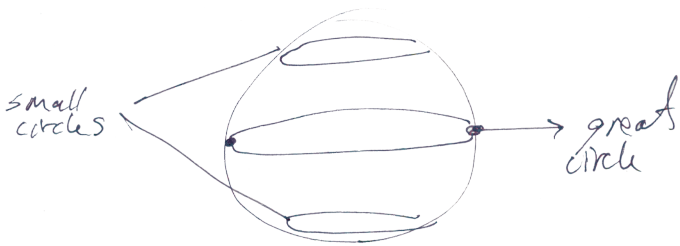
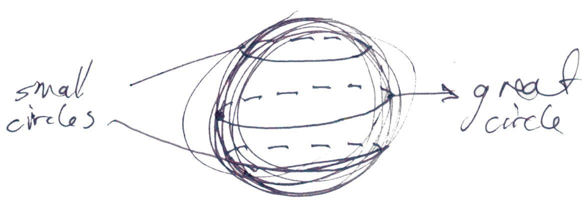


Fig. 3.2 | Drawings of a great circle



1/3 - Metre Timeline

I begin with a book, *The Inter (Si) Metric System and How It Works* (1975), where writer Robert A. Hopkins gives insight into the history of the Metric System and its 'development', as well as singles out contributing factors that define its conceptualization. Hopkins introduces and credits Gabriel Mouton as the progenitor of this unitary system in which Mouton conceived of a principal unit of length that could be further sub-divided decimally. Mouton, a vicar of St. Paul's Church in Lyons, proposed a basic unit, taken "from the physical universe [as opposed to] the human body" (Hopkins 1975:10). Mouton's adopted unit of length was that of an arch, of one minute, of a great circle of the earth, which he referred to as "milliare" (Hopkins 1975:10). Hopkins compares this unit, calculated by Mouton, to that of "...a full line of longitude or latitude" (Hopkins 1975:10); as horizontal and vertical mapping lines of the earth[13]. To quote Rudolf Carnap once again: "[g]reat circles are the curves obtained by cutting the sphere with a plane through the sphere's centre. The equator and meridian of the earth are familiar examples" (Carnap & Gardner 1995:134). This unit introduced by Mouton is still used in contemporary navigation, referred to as the 'Nautical mile'.

Mouton is most well known for his work *Observationes Diametrorum Solis et Lunae Apparentium* published in 1670 (Gabriel Mouton 2004). His focus on 'studied interpolation' and 'a standard of measurement' was based on the pendulum[14]. Mouton's importance is substantiated not only through his suggestion of a linear form of measurement, but the addition of the decimal system to this unit, which is still in use today. However, Mouton's definition of mille or milliare was not adopted, nor was it employed at the time of its conception. It was only until a century later that his concept of such a unit was revisited and labeled as the metre by the French Academy of Sciences. In 1790, there was a drive to reform measurement and to conceptualize a new device, due to the inaccurate results produced by the pendulum. Hopkins writes that recommendations made on this primary task – for eample, defining a new unit of length measurement - were contained in a report dated March 19, 1791 (Hopkins 1975:11).

This politically important and viable means to attain global recognition, through reform and appropriation of scientific methods, was attractive in the face of traditionally accepted uncertainty. The French thus embraced this search geared towards attaining greater certainty and knowledge. Hopkins makes reference to historian Edward F. Cox, who discussed the metre and the metric system during the late 1800, where science became more popular and was often associated with 'advancement' in an 'age of progress' (Hopkins 1975:13). This scientific development resulted in a directive to the French Academy of Sciences, who decided on a unit equal to one ten-millionth of the length of a quadrant of the earth's meridian. This unit became known as the metre, derived from the Greek word metron, meaning "a measure" (Hopkins 1975:11).

In 1793, Pierre Mechain and Jean-Baptiste Delambre carried out a expedition which span over six years, the culmination of which marked the metre measurement as 'fact' in November 1798. This unitary measurement, specifically designed to derive measurements of length, was later applied to determine measurements of weight accordingly. To secure and solidify both of these standards of measurement, a platinum metre and kilogram were completed the following June, in 1799 (Hopkins 1975:11).

Hopkins again makes reference to Edward F. Cox, highlighting the international traction and global recognition that this system began to receive: "The metric system was the scientifically recommended one in an age when science and its products were being welcomed into society" (Hopkins 1975:13). It is evident, however, that the metre device has changed and has continued to change since its conception. The following timeline is constructed from these two sources, *The Inter (Si) Metric System and How It Works* and the *NIST* (National Institute of Standards and Technology) online webpage, as it charts the metre's protracted devolvement.[15]

Timeline

1670

Based on the pendulum, a reform on length measurement was presented by Bishop of Autun, Charles-Maurice de Talleyrand.

1790

Mouton initiated the notion of linear measurement. In addition, he based this principle of length on the pendulum's swing (in Lyons, France).

1791

Recommendations towards defining a new unit of length measurement were found in a report on March 19th. It was in this year when the move from the pendulum, something physical, to a hypothetical unit was made; to that of one ten millionth of a quadrant of the earth's meridian (one ten millionth of an arc representing the distance between the Equator and the North Pole).

The term metron was appointed, literally defined as "a measure." Further, this new unit was applied to not only the standard of length but, weight and capacity were all to be derived from one single measurement as well.

1795

The multiples of this unit were defined under the same terms of Greek prefixes, namely deca = 10 and hecto = 100. Subdivisions received Latin prefixes, deci = 1/10, centi = 1/100.

1796

The construction of the final standards, a platinum metre and kilogram, were completed in June.

1798

The task to develop an international measuring system was initiated, inviting European countries and friendly neutral sates. Nations which accepted include: Italy, Denmark, the Netherlands, Spain and Switzerland.

1799

In June, the casting of the metre in platinum was completed, as well as the kilogram.

1851

International Exhibition.

1855

International Exhibition.

1862

International Exhibition, where an international committee on coinage, weight and measures met in Paris.

1874

According to the NIST Reference on Constants, Units, and Uncertainty website, the metre was cast in a platinum-iridium alloy, known then as the "1874 Alloy."[16]

1880

17 nations officially accepted the metric system, at least for government purposes.

1889

Revised Alloy was used, comprising of only 10 percent iridium, and measured at the melting point of ice - 0°C.

1927

At the first CGPM (General Conference on Weights and Measures), the metre prototype was defined as the distance, at 0°C, between the axes of two central lines marked on the bar of platinum-iridium kept at the BIPM.

1960

At the 11th CGPM (General Conference on Weights and Measures), the former prototype was replaced by the definition based upon a wavelength of krypton-86 radiation.

1983

At the 17th CGPM, this definition was introduced and accepted as the metre:

"The metre is the length of the path travelled by light in vacuum during a time interval of 1/299 792 458 of a second" (NIST 1998).

What can be deduced from this very brief timeline, in conjunction with a perceptible, long-term desire for and pursuit of accuracy, are the inconsistencies of measurement. The ever-changing evolution of measurement and the search for 'accuracy' fundamentally exposes 'inaccuracy', and suggests that accuracy is as relative as much as it is 'absolute'. In my opinion, the fissures that exist in this brief history of the metre bring into question alternative/explorative methods of measuring. In other words, as soon as a definitive definition is adopted, later tested and found to be inaccurate, the variability and consequent uncertainty of the method is revealed. However, with that said, the metre, or any universal unit is, in theory, an undeniably valuable tool. It can reasonably be argued that it is only once the agreed unit of measurement is used as a tool, and tested though physical application, that inconsistencies reveal themselves. This can be said of any form of measurement wherein that which is tested, sets the expression of the results; made clear by Lindley in the Uncertainty section (Lindley 2007: XI).

2/3 Accuracy and measurement

In the following section, I will be looking at three authors that explain and, in their own words, describe measurement as it relates to physics. In addition, I will refer to Carnap's exploration of one of three principles within science; classificatory, comparative and quantitative. This undertaking aims to clarify not only the ideas around what it means to measure, but also to define its application (specifically to the sciences) which rests on assessment and calculation geared towards observation and recording (un)observable occurrences. My focus is not on the authors themselves, but on their definition of what they perceive measurement to be, relating to science. These quotes aim to clarify and, in some cases, to define measurement as an act/application as well as a methodology/philosophy. What the authors unanimously make clear in the following selected quotes confirms the level of accuracy involved in a comparative methodology, which relies on specified standards and specific units. M. C. England, H. J. J Braddick and Sir Alan Cook define measurement as follows, listed under the section heading Facts.

Facts

In *How To Solve Physics Problems* (1979), M. C. England centers his introductory passages on measurement, systems of measurement, conversions of units, areas, rules, short time intervals and, what I would like to focus on, 'accuracy'. England writes: "Since calculations in Physics are based upon measurements that have been made, the answer obtained is no more reliable than the least reliable measurement we have made" (England 1979:8).

H. J. J. Braddick in *The Physics Of Experimental Method* (1966) discusses aspects of errors and the treatment of experimental results. Braddick takes into account the result as well as the standards that these results are measured against. He states: "This quantitative estimation of experimental uncertainty is clearly important when we compare the result of one experiment with another in which some condition is altered, and have to decide whether the observed differences are significant, or when we compare experimental results with a theoretical calculation and have to decide whether or not the experiment supports the theory" (Braddick 1966:6).

Alan Cook's thoughts on measurement in *The Observational Foundations of Physics* (1994), insists that: "Measurements are necessary to establish the correspondences and to ensure that the representations of reputedly similar observations are compatible. Every measurement consists of comparing some quantity with a standard quantity of the same type, and thus assigning a number to the measure unknown quantity in terms of that standard" (Cook 1994:7). Cook gives examples of length by comparing objects by means of their physical differences when laid against one another.

Cook also points out the level of detail and precision needed to conduct such experiments, so that only the most accurate data can be collected or revealed. Specifically, he states that: "The precision of any measurement is determined both by the accuracy of the comparison with the standard and by the precision with which the standard quantity can be realized and reproduced" (Cook 1994:7).

Observation

Accuracy

Standard

The first important point that I consider these authors to make relates measurement to accuracy. What can be deduced from these extracts, and what is not stated but implied, is that in order to ensure 'precision' the parameters need to be defined, including the units and standards, before a calculation takes place. These parameters fundamentally determine the standard, for, as expressed by England, "the answer obtained is no more reliable than the least reliable measurement" (England 1979:8)[17]. The domain of the experiment, which defines and expresses what is measured and tested, determines the parameters . Repetition is another means of attaining accuracy. The act of repeating an experiment, and the implication it has to the entirety as well as the first, second and third result, could define the regularities of differences that occur within an experiment. In repeating an experiment, the conditions, which frame the experiment, must remain consistent throughout. Factors like time, sterile environment, lighting and quantity would have to be taken into account. This is to ensure that the results are credible, unless the accuracy of the results or tools used to measure is the aim of the experiment.

However, as stated by Carnap in the first section, any result is still a result, whether consistent with the standard or not[18]. Facts (like those singular occurrences described by Carnap) carry as much merit as any other result. Results then undoubtedly contain and hold record of the experiment. But by proving that a result is false, or that the result does not reveal what is being hypostasized, one can deduce, linking back to a point made earlier, that accuracy is relevant or instance-specific (in part due to the primary difficulty of marrying the theoretical with its practical application, and vice versa).

A second point I would like to consider relates to Braddick's thoughts on 'the standard'. In my opinion, the standard perhaps becomes the numerical value in which one case stands in relation to another, where the compared value may be eliminated or discredited on the basis that it does not reflect, or is not equal to, what has been selected as the standard. However, results that do not reflect the

standard are not eliminated all together, but included as such data reveals other avenues that can be tested or altered in order to expand alternative methods and research. As already mentioned in an earlier section regarding Carnap's view of statistical law: "Even when statistical law provides only an extremely weak explanation, it is still an explanation" (Gardner & Carnap 1995:8). However, as the practical implication in relation to the theoretical is involved, what Braddick confirms is that the practical and theoretical have a somewhat symbiotic relationship in the sense that the one feeds and informs the other. It is inevitable that these two aspects, within any field, have the potential to contradict one another in some cases. But in Quantum Physics, as indicated by Braddick, contradictions and failures are integral to the experiment, providing greater insight into what is tested, and are thus included.

Result

What can be taken from this section, firstly, regarding measurement of any kind, is that the principle of a chosen unit is integral. The second point is that this unit needs a standard to which the measurement can be compared. And lastly, in order to reflect accuracy, the measurement needs to be repeated (in theory) so as to eliminate uncertainty over what is measured, and to be presented as not only a fact but also a universal law.

3/3 Measure through comparison

I want to briefly engage with Rudolf Carnap once again, specifically his description of the dynamics involved in an experiment, and the three different principles within science (classificatory, comparative and quantitative). In this text, Carnap points out and extensively details what has been mentioned by Braddick, England and Cook regarding measurement in a hypothetical experiment:

> To illustrate, consider the concept of weight before it was possible to give it numerical value. We only have comparative concepts of heavier, lighter, and equal in weight. What is empirical procedure by which we can take

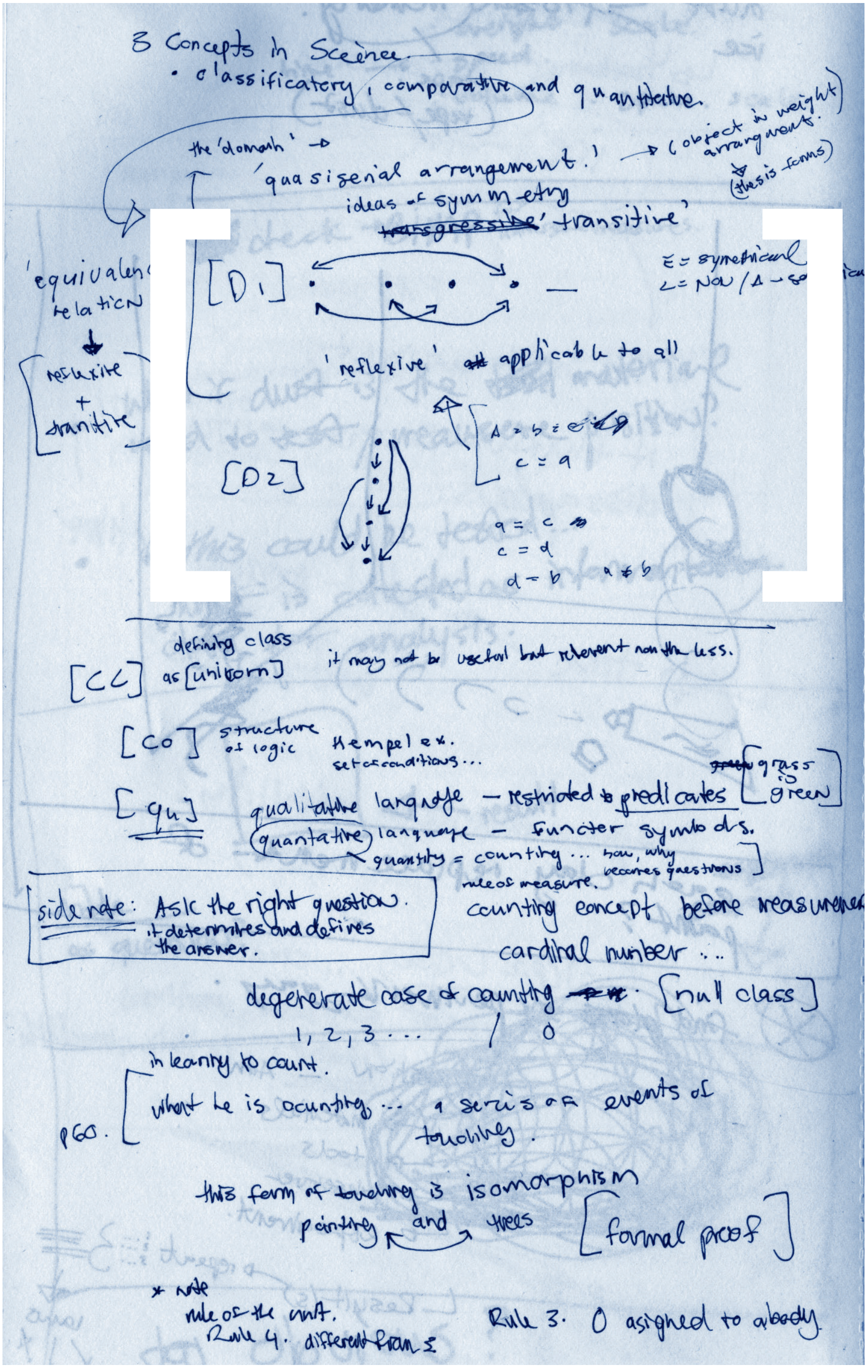


Fig. 3.3 | My notes on Carnap's reflexive example

> any pair of objects and determine how they compare in terms of these three concepts? We need only a balance scale and these two rules:
>
> If the two objects balance each other on the scale, they are of course equal in weight.
> If the objects do not balance, the object on the pan that goes down is heavier than the object that goes up" (Gardner & Carnap 1995: 53-54).

What Carnap introduces here is the concept of comparative assessment/ measurement. That is, by looking at two rules that can be applied to two objects on a scale, one can derive the concept of weight. Carnap further assigns symbols to these empirical values, such as an "E" when the objects are equal in weight on the scale or an "L" when one object 'weighs less' than the other object. What this aims to illustrate is one manner of understanding a concept within science, namely, a comparative method of measurement.

What Carnap continues to define is the domain of both the experiment of assessing weight between objects, as well as that this principle, in this instance, is applicable to any body that has weight as a first condition. What Carnap further indicates is that within these two 'rules' the conditions get more specific, potentially creating a stratified structure – a "quasiserial arrangement" - which is conditional (Carnap & Gardner 1995:54). As seen in my notes, I aim to explore and describe such structures and concepts accordingly.

To further clarify, what is discussed in these notes is a method of understanding the conditions and rules involved in an experiment. I am inclined to label this as the 'philosophy of the experiment'. In a variation of Carnap's explanation, I will substitute letters for dots, to reflect my interpretation. As indicated by [D1] and [D2] of Carnap's explanation (Fig.3.3 on the left), I would like to discuss, his explanation regarding a comparative concept in science:

a b c d

Fig. 3.4(a) Symmetrical

Fig. 3.4(b) Asymmetrical

When arranging objects in a quasiserial arrangement, patterns like symmetry become ways of describing such stratified structures. For "E" to be defined as the standard of equality between the objects presented as (a),(b),(c) and (d), a transitive concept must be inherent in the objects. As discussed earlier, Carnap writes to such an application of meaning, in a quote I referred to earlier, "We have precisely specified the meanings of "1", "3", "4", "+", and "=", the truth of the law "1 + 3 = 4" follows directly from these meanings" (Carnap & Gardner 1995: 10). In other words, if (a) = (b),(a)=(c) and (a)=(d), then (b) = (a), (b) = (c) and (b) = (d),and so on. So if all the objects are interchangeable and transitive, (E) can be described as reflexive[19].

To illustrate laws "E" and "L", see diagrams of Fig 3.4(a) and Fig.3.4(b) on the left: These diagrams show two stratified structures, indicating transitive and reflexive qualities that aid to what is discussed above; symmetrical and asymmetrical patterns.

At this point, I hope that the idea of 'reflexivity' and 'transitivity' expressed by Carnap, as a concept, becomes clear, by way of the variations of this document, (wooden version of thesis and written component) [if... then]. As they, [if... then], exist in and of weight and fall within the domain of weight and measurement, it is possible to employ this method of comparative measurement. However, this means of measurement or comparison demands a degree of sensitivity on the part of the reader/viewer where, if variation does occur, the implications of this variance, questions 'transitivity' or 'reflexivity'. For instance, if one version is heavier than the other, what are the implications of this variance? By way of assessment through physical acts (material body/weight), the body becomes the tool measuring the data; an act in direct contrast to Mouton's conception of accuracy, which emphatically called for a measuring system based on the physical universe and not on the body. I am of the opinion that this assertion contradicts itself, for are we not also physical beings?[20] Importantly, this ties to a point made in the first section, looking at empirical and theoretical law, where meaning is assigned rather than inherent to symbols. Here, I would like to elaborate on Carnap's explanation of a quantitative concept in science, with particular focus on isomorphism. It is here where the physical and the haptic meet the symbolic.

Quantitative

“If we had not first had the ability to count, we would be unable to measure” (Carnap & Gardner 1995:60).

Carnap introduces the term “nonnegative integers” (Carnap & Gardner 1995:60), suggesting that with regards to numerical value, that which is absent in an answer is as relevant as that which is being asked. As an example, Carnap uses a classroom. In this classroom, states Carnap, there are twenty chairs. If someone were then asked how many pianos are in the room, the answer would immediately be acknowledged or understood as ‘0’. I find this concept of nonnegative integers outlined by Carnap, which define through absence, to be of great interest. However, in addition, I would like to focus on another point Carnap raises relating to when a child learns how to count. Continuing with the example of the chairs in a room, Carnap describes the action of a child in this room: “He walks about the room, touching each individual chair while he says the number word” (Carnap & Gardner 1995:60). What this suggests is that it is not the physical object, but the physical act, the series of events/touches and the assignment of value to this act, that is used to count and determine numerical value. Carnap terms this act as an isomorphism. He gives a second example to explain this act of counting, stating that if a child is asked to count a number of trees, the factor of ‘distance’ corrupts this act. That is, when pointing and counting the series of ‘pointing acts’, as opposed to physical touching, the child is prone to make error, finding difficulty in the act of “making sure he points to each tree once and only once” (Carnap & Gardner 1995:60). An example of such a physical act could be perceived as more relevant here if applied to the following example. If the weight of the document could become the focus, as opposed to the textual information, can it be argued that this material object, of a like domain (weight, shape, size etc.), informs the text and vice versa. In other words: if/then.

Conclusion

What can be concluded in this section is that accuracy and inaccuracy are mutually dependent, and inform each other. This is evident in the metric system and the

various editions over the course of 344 years, and by Braddick, Cook and England's focus on the conditions needed for accurate reading of measurement around the variables of inaccuracy. Following this, Carnap and his articulation of 'primal' means of measuring asserts that assessment and comparison are regarded as both a common and valid means of measuring.

I apply these thoughts explored by Carnap's comparative measurement practice to endorse and validate the philosophy inherent in the material experimentations of my process. This becomes most evident when I explore and experiment with various materials as a means to make sense of, to measure my own position within contemporary structures/complications/parameters. In doing this, I can take these scientific investigations and reflect, from an autobiographical point of view, on measurements of my own physical strength, implying potential measurements of masculinity and social constructs. These visual codes are explored and measured in the following section, focusing on my process, where I appropriate these findings and express them through art making.

Marcel Duchamp

As an extension of the investigation of measurement, I briefly look at an artwork by Marcel Duchamp, *Three Standard Stoppages* (1913-1914). I follow such notions and questions of measurement through a number of experiments in the section which follows, titled Me+.

Duchamp's notoriously tongue and cheek relationship with the art world, and his resilient attitude towards elitism or the so-called 'bourgeoisie' in art, is one that has caused frequent debate. Such debate often circles around the very materials used to produce his art works. By way of the readymade (or found materials) and the connotations linked to the materials involved, Duchamp questions the relationship of an object's function, or, rather, its status. I consider this to be most present in his work, the *Three Standard Stoppages* (1913-1914) (Moma.org). Duchamp has taken an historical, widely recognized and esteemed device (the metre), and then represented this device through alternative applications. What is more is that he does this, in my opinion, in a manner that undermines its significance and synonymy with accuracy. Duchamp drops a string - cut to the length of one metre and held at the height of one metre; the resulting curved string offers new readings for the metre's supposed "length". Further, the chance involved and the undeniable inaccuracy draw attention to and mock the inaccuracy inherent to the prestigious measuring system that they reference.[21]

Fig. 4 | *Three Standard Stoppages*, Marcel Duchamp | (Moma.org)

me+

I use my body to measure. By doing so, I reflect on: 1) the application of the energy spent while bending steel, and 2) the distance realized by my arm's length when reaching as far as my body allows. This reveals 'empirical data' of and through the sculptural gestures made onto material. Thus, my body acts as the point and source of measurement. In this section, I acknowledge the imperfect science of using the body as a tool for measurement. However, unlike Mouton, I embrace these imperfections as part of the measuring process.

To reiterate, Gabriel Mouton, the progenitor of a basic unit of measurement, asserts that a device of measurement should be derived from the physical universe and not the human body (Hopkins 1975:10). In using myself as a measuring device, I acknowledge and accept the inaccuracies produced from what I measure. However, in adopting this mode of measuring, I also test the notions or limits of physical measurement as a means to grasp information. Thus, 'as an artist' I 'measure' and poetically respond to these scientific investigations. The experiments that I construct begin to reflect and imply the body [my own], alluding to my character, when meditating on notions of 'intuition' and 'precision'. These tests and measurements suggest states of being, nuances, and precariousness as opposed to scientific numerical accuracy. The creation of these measured findings begin to act as the set of Laws from which I choose to operate. My body is made present and I aim to reflect this bodily presence, and subsequent absence, through the following scenarios developed from my everyday activities, such as bending steel, picking up twigs and balancing various objects.

In this section, I incorporate ideas from Carnap, Lindley, Heisenberg, Braddick, England and Cook, as an underpinning theoretical framework, to which I respond poetically through art making.

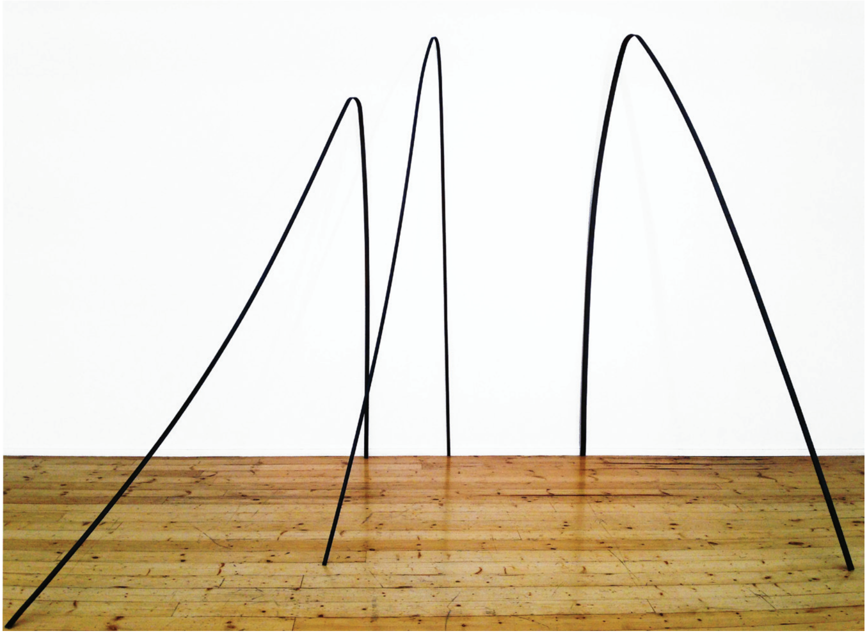


Fig. 5.1
Lines
Mild Steel
Dimensions Variable
2014

Exhibit A - *Strength*

Set of conditions:

1 x Body [My own] / 61.78 kg / 176 cm

3 x Mild steel flat bar

Gravity

The domain and restrictions listed above and in each experiment that follows, serve as a means to define or determine the 'reading' of the acts involved:

- the length of my arm
- the geometry of the bent steel
- the energy spent through the application of force between two physical bodies

I step on the flat bar, reach down and pull the end towards my body. The stretch can be measured as far as my arm allows. I pull the steel towards me until it rests flush against my body. I repeat this three times.

In addition to this, there are measurements made between each act to determine the reach of my arm, the energy used (through a collection of sweat, see list of works) and through visual comparison. Further, the readings of these diagrams imply the presence of the body, but also an absence. The reader is provided with this data, as well as the results by way of a collection of my sweat, implicating the bodily acts involved. The proposition: Can the tangible form accurately infer the act of bending, without having prior information regarding the methods involved? In other words, could the material show, through its manipulated form, that the body, instead of a machine, bent it? (Can this be deduced by inaccurate geometrical kinks – as opposed to mathematical precision in curvature and Non-Euclidian geometry)? This speaks to the tangible and the tacit, perhaps alluding to the formal merging of Faktura and Isomorphism? Apart from the bending of steel, one could ask if the data pertaining to this act, through bending, measures its behavior? Which further questions how the energy is measured - through the sweat collected, or the geometrical structures created?

This data reveals that the visual material, which appears static, has been readjusted and this act involves movement and motion. A physical change in the nature of the material - its state of being - visually reveals the product of the body's force. It echoes the gesture of the body's motion; revealing its own gesture in material form.

Fig. 5.2
Getting Off
Adhesive Tape
Dimensions Variable
2014

Exhibit B1 - *Grit*

Set of conditions:

1 x Body [My own] / 61.78 kg / 176 cm

1x 550 mm Adhesive Tape

Gravity

The first measurement, again, lies within the stretch; as far as my arm allows. With two arm lengths as the unit of measurement, the material begins to reflect my own body's reach. This material measurement, manifest in condensed tape, is then placed against the wall. The wall behaves as a constant, and the tape as the test. The duration of the piece then measures the relation between adhesiveness and gravity.

As the adhesiveness of this object attracts surrounding residue, it reveals not only the duration of the stickiness to gravity, but also the surrounding materiality and specificity of the space in which it is placed. The surrounding residue becomes another variable in which the object retains remnants of the acts involved. Therefore the set of conditions become visible, implying a history and marking/measuring time.

The second exploration of this means of measuring through material, can be seen in the following experiment.

Fig. 5.3
Spray Paint
G-clamp and Spray Paint
Duration 00.16.03,73
2014

Exhibit B2 - *Grit*

Set of conditions:

1x 12” / 300mm Orange G-Clamp
1x White Spray Paint Can. 340g. 12.07 Oz
Gravity

The can is placed between the grips of the G-Clamp, in which the Clamp’s thread is twisted until the can begins to spray its contents. The spill and the duration of its spray, measures the life-span of the can, through the grip and its now empty contents.

The notion of measuring time through material is one that creeps through, most present in the rust of the steel, the stickiness of the tape, as well as the spill of emptied out spray paint.

Exhibit C - *The Metre*

Set of conditions:

1x Tattoo
1x Lipstick
1x Body [My own] / 61.78 kg / 176 cm
2x Elastic Bands
4x Gold Nails
Gravity

In the series of experiments that follow, I undertake an investigation into the metre. By applying a physical tool, through various sets of conditions, each of the experiments test the level of accuracy involved/implied.

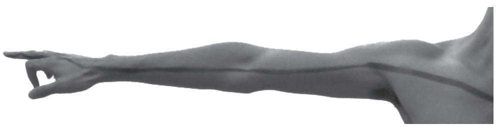


Fig. 5.4
Metre
Lipstick and My Arm
1m
2014

Exhibit C1 - *The Metre*

Set of conditions:

1x Lipstick

1x Body [My own] / 61.78 kg / 176 cm

Gravity

By removing the cap of a drawing tool such as lipstick, I take the point, and draw onto my body, from fingertip to the edge of the opposite shoulder. What this aims to measure is a metre, onto my own body. This act runs counter to Mouton's argument that the body is not an accurate tool of measurement. It is here, again, that I deliberately use the body as both the measurer and the measured. The drawing of the line references the metric system as a universal system of measurement, and applying it, literally, I become the tool that measures.

Fig. 5.5
Metre/2
Ink and My Arm
1m
2014

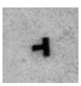


Fig. 5.6
Metre/2 Close-Up
Ink and My Arm
10 x 10 mm
2014

Exhibit C2 - *The Metre*

Set of conditions:

1x Body [My own] / 61.78 kg / 176 cm
Gravity
1x Tattoo

In addition to the first experiment, I have measured one hundred centimetres and marked it onto a piece of string. I then taped it to my body, following the curves, from fingertip to where it ends. Using a cropping symbol (⊦), used in the field of design but also as a symbol for Inference, I marked a metre on my body.[22]

This application, as with the lipstick, follows the curves of my body. Using Duchamp's Three Standard Stoppages as reference, geared toward an alternative stance of the metric metre and its aim for certainty, I physically explore.

Using my arm's length as a tool for most of the work indicates that this inaccurate metre is implicit in all of the works. To claim this as a predictably inaccurate tool of measurement, I will call it the LIAR (Length In Arm of Ruann). This notion is further implied in other objects; using the length of my foot, my body weight and my arm's stretch, and so on. These measurements, taken from and by myself, have a relationship with each other. These measurements start to form new relationships, which in turn start to measure aspects of my self – outside of what the first reading would permit.[23]

Fig. 5.7
Y
9 Carat Gold Nails and Rubber Band
1m
2014

Exhibit C3 - *The Metre*

Set of conditions:

2x Elastic Bands
4x Gold Nails
1x Body [My own] / 61.78 kg / 176 cm
Gravity

In this experiment, the aim is to test the limits of the materials involved, in addition to testing the metre itself. Applying the metric system, namely the metre unit, as tested in the previous experiment; this process starts by stretching the rubber band to that of a metre's length. Thereafter, I place the elastic band between two, solid gold, nails, vertically, as well as horizontally.

The tension in the rubber band decreases with each stretch made. The action involved in the initial stretch - the stretch made by hand prior to the band's placement between the two nails - is a result of the body's intervention with material. An element of chance is introduced in this process. The material reaction is unpredictable and becomes a variable as well as that which is tested, namely, the strength and integrity of the elastic band. The material is further put into question when a secondary material is introduced, with the addition of the gold nails. In this experiment, the value of gold and its rich associations, is juxtaposed with a common elastic band and is tested, or measured, against its pull. In addition, the gold takes the form of a nail, again undermining the nobility of its usual status and acts as placeholder for the body, by extension, in the associations made to objects for the body (such as body adornments/bodily functions).

As alternative modes to measuring the body, both examples above, for instance, act as references to and offset my own notions of measuring. The materials, such as

Fig. 5.8
Y/2
Rubber Band
1m
2014

gold, elastic bands, steel as well as sellotape, function as secular representational objects of the body. Referenced in these works are Bob Flannigan's means to test pain and Marcel Duchamp's appropriation of the metre.

Results:

In this particular experiment, in the work titled "y", additional occurrences pertaining to that particular work have been noted as follows.

Initially the "x" and "y" works aimed to act as tools to locate one's position within the space using the 'x' and 'y' axes, as employed within mathematics. It has been observed that during the exhibition, the rubber band of the work titled "y" snapped and had to be replaced three times. At first, I did not consider it seriously, and continued to replace the work with a new rubber band. It was only later, during my underlined investigation regarding masculinity and the consistent means to prove its validity, that I was reminded of a genetic instance.[24]

To give context to my argument:

"The Y chromosome is present in males, who have one X and one Y chromosome, while females have two X chromosomes" (Genetics Home Reference. 2014).

"Because only males have the Y chromosome, the genes on this chromosome tend to be involved in male sex determination and development. Sex is determined by the SRY gene, which is responsible for the development of a fetus into a male" (Genetics Home Reference. 2014).

By way of rereading the chromosome structures and how the 'y' chromosome within men, containing SRY gene, determines the sex in a fetus, tweaked my interest. My investigation, by way of metaphor, and expression through material, thus revealed an interesting manifestation through the inability to perform a task at hand, namely, the stretch of a metre. In testing material as a means to test masculinity, what is also demonstrated is that the constructs that define masculinity (as strong, durable and tough) are something that cannot withstand the parameters on which it safely rests, for example, failing to sustain its function and purpose.

Fig. 5.9
Strength
Steel Powder, Cement, My Tears
1 x 2 x 2 cm
21 g
2014

Exhibit D - *Matter*

Set of conditions:

1x 200g Iron Powder
1x 200g Cement
1x My Tears
Gravity

In this experiment, I use a combination of materials adding to my own body matter, wherein my matter acts as the binding agent between grinded down steel and cement.

The experiment is initiated by crying into the cement, thereby creating “concrete” which is almost unfailingly recognized as a symbol for stability, physicality and strength. In this work, Strength, I play with the traditional associations of concrete (as a noun and a verb) to critique the notions of strength. In doing so, it may be argued that the juxtaposition between a poetic and traditional reading of mixing concrete, reveals ambiguities and potential in the metaphoric measuring of masculinity.

Fig. 5.10
Totem
Pine
218 x 10.5 x 5 cm
2013

Exhibit E1 / *Balance*

Set of conditions:

1 x Body [My own] / 61.78 kg / 176 cm
1 x Pine Wood Beam / 218 x 10.5 x 5 cm
Gravity

In the exhibit there are two art works that test this notion of balance: Totem and Adaptor.

I take Totem, place it vertically, in position x. It wobbles, then stays. I moved Totem to position y. It doesn't balance. I move Totem to position R. It stays.

In this experiment, I undertake a series of positions where the object, a wooden beam/totem, is placed by my own hand, to balance on its own. In doing so, I have developed a "sense" or "feeling", where I can start to predict the position where the object feels most comfortable.

I start to use words such as "feel", as opposed to "predict", as it implies that the object involved has its own intention, at times in opposition to my own. This is most present in the next experiment, Adaptor.

Fig. 5.11
Adaptor
Found objects
Dimensions Variable
2013

Exhibit E2 / *Balance*

Set of conditions:

1 x Body [My own] / 61.78 kg / 176 cm
1xFound Plank
Gravity
10x Oxidized Metal [EMW3 shape]
1x Wire Piece

I take the twelve metal shapes; I place them all on the wire, which is attached to the wooden plank. Its angle is about 75º at its base. I take the wooden plank and hold it, upright. I start to slowly remove one metal shape, and the plank falls over. I pick it up and take off another. And another. And another. Until the plank is equalized through being countered in weight, allowing it to stand.

Here, the objects found collectively balance. The weight of the metal [EWM3 shapes], which is attached to the wire, which is attached to the plank, finds equilibrium [through the artist's intervention]. The objects involved react differently to the environment in which it is placed. In both Totem and Adaptor, each installation changes relative to the surroundings, revealing irregular patterns and fluctuations.

Conclusion

As a constant in all of these experiments I involve myself in these works as the subject of measurement, and as the tool that measures. Central to these investigations are issues of body, strength, size and weight. When measuring these, through the philosophy of the sciences, I can reflect on the standards of the ideal male body, and in testing these, question social expectations and ideas of masculinity. Sensitivity towards materials and seeking balance within chosen materials brings to the fore the role of my body and its limitations. In addition, I hope it has been demonstrated that the body has the potential to act as the device that counteracts/displaces material mass, lending itself to the potential for metaphor. I seek to find balance in objects ruled and determined, not only by the associations we bring to them, but through the scientific and gravitational laws that they embody. Through this process, it has, I hope, been substantiated, even for fleeting moments, that these laws have gaps or that there are breached moments in a system of supposed certainty, and that a tenuous position between certainty and uncertainty exists.

Thus, as alluded to, with particular reference to the history of the metre, accuracy and inaccuracy are at the heart of the evolution of measurement as Carnap argues. Through the scientific approaches to material, that facts are constructed and substantiated. I too accept these notions where I, through the manipulation and measuring of material (as the tool practicing the measurement), start to construct facts.

By way of Heisenberg's principle of uncertainty, one is made aware that the nature of things, or rather the behaviour of material, is one that consistently changes in accordance to the tools used to measure this very phenomenon (as indicated by David Lindley). Measurement itself changes due to the observations that we make, and continue to make, and also onto which we build. This raises various questions pertaining to the unseen, where mood and nuances are revealed through the intimacy of touch. Questions that I ask myself through measuring, exploring and testing are: could one tap into elemental behaviour as a means to understand how one relates to objects? Or is it possible, and if so, how, for one to read or manipulate matter through understanding its structure/behaviour? Do we share some biochemical bond, and could this be regarded as a shared knowledge with matter, as yet unknown to us? And finally, as mentioned in the opening of this research, the haptic approach to material is the means by which I explore material measuring.

It is possible to imagine that the use of symbolic language and the philosophy around measurement can be applied to all actions and physical expressions. This suggests that every act, experiment or occurrence carries merit, and can thus be labelled 'fact', as Carnap would confirm. Through my practice, it is in the physical exploration and measurement of material and its nuances that unexpected behaviour is revealed.

In the practice of creating works and exploring matter, I find that the ultimate question, and simultaneous answer, rests in a sensitivity towards the physical, the haptic, and the interaction with the actual stuff that we are undoubtedly part of. I follow after the thoughts of Heisenberg who suggests that material is the carrier of information, and it is made so through the physical, "matter is in itself not a reality but only a possibility, a `potentia'; it exists only by means of form" (Heisenberg 1958:89). When reflecting on these words, I hope that the act of making, touching and exploring material, potentially speaks to, or provides a grasp of the unknown. As revealed in this thesis, the search for the known, the 'accurate', reveals the opposite. The artist then has the opportunity to follow suit and to take these investigations on as a poet, a questioner, and an investigator. In doing so, the empirical world of scientific discovery is used to explore the questions of states of being.

Endnotes:

1. For information on the Vienna Circle see: M. Neurath & R. Cohen, 1973. *Empiricism and Sociology (Vienna Circle Collection)* (Volume 1). Softcover reprint of the original 1st ed. 1973

And an extensive background on Rudolf Carnap by P. Schilpp.
See: Schilpp, P. (1963). *The philosophy of Rudolf Carnap*. Open Court: La Salle.

2. Co-authored and edited by Martin Gardner.
Carnap, R & Gardner, M. (1995). *An Introduction to the Philosophy of Science*. Dover Publications.

3.Bi-Conditional as term but concept i find to be particular interest to me, regarding objects. See: (Carnap & Gardner 1995:4).

4. This will be reflected on in a section, titled me+.

5. Could be isomorphic. Carnap introduces a concept to pertaining quantitative measurement, as it pertains to the haptic. This is expanded on as the section unfolds.

6. In the repeated underlining and questioning of the term 'language ' (including, to a degree, 'symbol') in Carnap's examples and my expansion thereof, it is no doubt becoming increasingly apparent that the seminal texts on these topics (those written by, for instance, Jacques Derrida, Roland Barthes and Ferdinand de Saussure) have been neglected. It needs be stated that such terms, while of consequence (and indeed unavoidably manifested throughout my investigation), are not the focus of my thesis. My objective is centred on material and the physical, the investigation of which is framed through and expands on a particular text, namely, An Introduction to the Philosophy of Science by Rudolf Carnap.

7. See: Tim Ingold's book, *Being Alive: Essays on Movement, Knowledge and Description* (2011). In the second section, Ingold looks at Materials against Materiality. He begins this section with an experiment, (I have appropriated, wooden competent) on his idea he introduces:

"Before you begin to read this chapter, please go outside and find a largish stone, though not so big that it cannot be easily lifted and carried indoors. Bring it in, and immerse it in a pail of water or under a running tap. Then place it before you on your desk – perhaps on a tray or plate so as not to spoil your desktop. Take a good look at it. If you like, you can look at it again from time to time as you read the chapter. At the end, I shall refer to what you may have observed" (Ingold 2011:19).

What I will allude to later, when unpacking comparative means of measurement, as discussed by Carnap, is this particular physical/theoretical interplay that I hope will become more apparent as the research develops, the reflexive/transitive relationships between If/Then.

8. However, the exploration of theoretical laws can reveal new singular statements, which are not universal laws, but such statements, at the same time, can substantiate theoretical enquiry.

9. Instances where the term Faktura, a formal element 'pertaining to material surface', is discussed in *Realism, Rationalism, Surrealism: Art Between the Wars* (1994) see pages: 100, 108, 114, 122, 127 & 129). Also see Shklovsky, V. (1965). *"Art as Technique" Russian Formalist Criticism: Four Essays*. Lee T. Lemon and Marion J. Reiss. Lincoln

10. On Wave Particle Duality, see: http://www.toutestquantique.fr/#dualite (Toutestquantique.fr, 2014)

11. See: Nairz, O., Arndt, M. and Zeilinger, A. (2002). *Experimental verification of the Heisenberg uncertainty principle for fullerene molecules*. See: https://vcq.quantum.at/fileadmin/Publications/2002-01.pdf [Accessed 26 Oct. 2014].

12. For instance, Carbon element. For further information, see:
Fullerene. 2014. Fullerene. [ONLINE]
See: http://www.sciencedaily.com/articles/f/fullerene.htm. [Accessed 26 October 2014].

13. To reiterate, Mouton's measurement is "based on the length of the arc of one second of longitude at the equator on the Earth's surface and divided decimally"
See: *Mouton biography*. 2004. Mouton biography. [ONLINE]
See: http://www-history.mcs.st-and.ac.uk/Biographies/Mouton.html. [Accessed 26 October 2014].

14. Pendulum: "an object connected to a fixed support in such a way that it is free to swing back and forth under the influence of gravity" "Pendulum" 18 August 2009. HowStuffWorks.com. <http://science.howstuffworks.com/pendulum-info.htm> 13 October 2014.

15. Fore more description see sources: http://physics.nist.gov/cuu/Units/meter.html and http://www.nist.gov/pml/index.cfm and Hopkins, R: 1975. *The Inter (Si) Metric System and How It Works*. AMJ Publishing, Tarzana, Calif.

16. For additional information see: http://physics.nist.gov/cuu/Units/meter.html

17. To expand on this notion of the domain, could the example of measuring paper against wood, both being of the domain of wood, perhaps be appreciated as a conceptual application of the term?

18. This alludes to performativity, wherein a set number of tests are performed and the result that is consistent or unanimous is accepted and set as a standard.

19. This is a concept that I would like to investigate not only in terms of theory, but also practically to reveal through material, as the written or physical expression of theory through material. These versions of the thesis then fulfil the requirements of a written component, which has already been indicated as but one version. However, the practical versions, as physical materials/art objects, that exist in conjunction with this document do not illustrate but exist in relation to one another, thereby revealing the material poetry that is present in a reflexive or transitive expression.

20. It can be appreciated that this view also has its complications, because we as physical beings do not have the same 'length of arm' as an example to measure, and from which to universally receive the same data. However, if the ultimate physical measurement is applied to the body and checked daily, does this potentially suggest that the body has the ability to measure that distance through repetitive acts? And does this ultimately suggest that measuring is just another form of performance all together?
21. Inaccurate, due to their slightly elastic

quality and inconsistencies in size, tautness as well as their tendency to fray and warp, yields in unreliable results.

22. Inference is the act or process of deriving logical conclusions from premises known or assumed to be true.

23. Alluding to alternative means of measuring, in cases of both the body as performer (Marcel Duchamp's *Three Standard Stoppages*) and the emotional/ pain barometer (Bob Flannigan's *You Always Hurt the One You Love*). See these works that are included in the additional data section starting at page 127.

24. See GHR, (Genetics Home Reference) a service of the U.S Notional Library Of Medicine [online: http://ghr.nlm.nih.gov/ chromosome/Y]

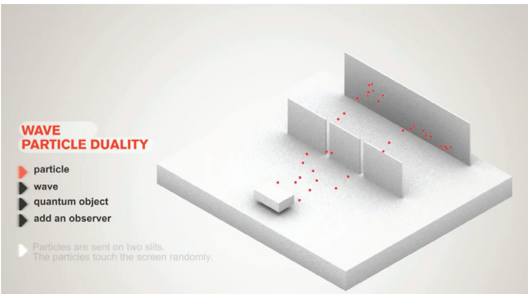
list of figures

In this section, a list of images, figures and diagrams are set as aid to the written thesis above. In addition to this, there is a section which follows that serve as extra information and not key to the argument but does however support the illustrations/drawings/renderings. What follows is a list of figures with corrisponding pages and breif caption for clear labling. Sources are acknowledged under the list of sources from page 136, at the end of the document.

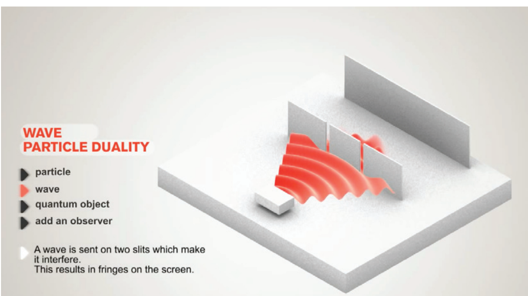
additional data

The aim of this particular section, acts as aid to the list of figures as well as additional information that is not part of the text, but has found its way into my scope and registers as markers or pointers that I find interesting. To my mind they link and act as data worth investigating. The images do not fall under the list of figures, but have captions and are sited under the list of sources.

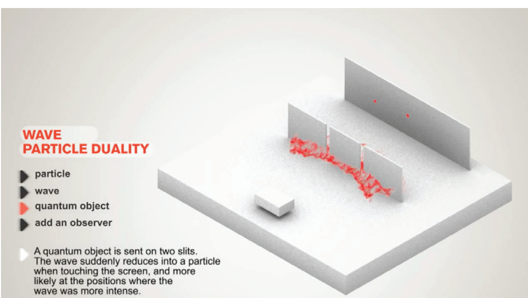
The first of which is part of the uncertainty section, discussing Heisenberg's uncertainty principle. Where diagrams that follow, 1, 2 and 3 have been adapted to conceptually link to the poetic licence of scientific information in the drawings of fig.2.2, Fig.2.3 and fig.2.4. (the flow between information and interpretaion is in the experiment of me drawing the information on the page. Not knowing if the ink will resond to the pressure applied and so on). These diagrams can be found in the form of a short clip that demonstrate the movement of particles, waves and quantum objects at: (Toutestquantique.fr, 2014)



1. Particle.



2. Wave



3. Quantum object

These diagrams above, to my mind, start to speak to what was discussed in the first section, e |t, where vigorous testing and chance start to reveal and rely on each other. This starts to tie into the Marcel Duchamp's section, which acts as an introduction to my own practice, whose work undoubtedly has a very strongly influence in my methodology.

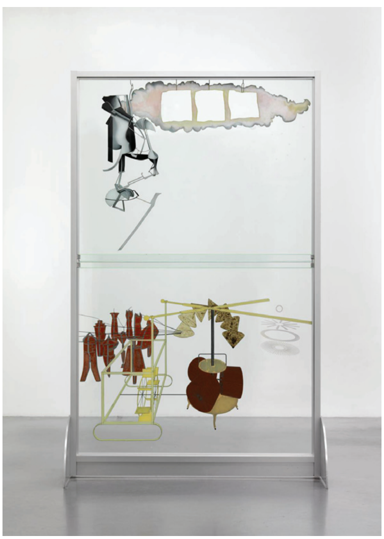
What follows, is additional information regarding the section entitled me+. The following images are scans of cotton swabs, that retain the collection of my sweat produced after each bend of the work titled: lines (fig.5.1) on page 87. An additional image of the experiment being performed, is provided as "proof" titled 'Bend.'

Reading 1,2 & 3 | Cotton Wool and Sweat | 50 x 50 mm | 2014

Bend
Bending Raw Flatbar
600 x 45 x 4 mm
2014

Duchamp's use of dust as a medium is what interests me and what I wanted to come across regarding the collection of residue in the work *Getting off*, Fig.5.2, page 90. In this particular experiment, where the aim was to measure through material, the following art works came to mind. Two particular artists, Marcel Duchamp, previously mentioned as well as Gabriel Orozco. Similar to Duchamp, Orozco sets out to use matter to measure through material, Duchmp's dust measures time, where Orozco takes his body in weight in clay (measuring not only time but energy spent/measuring the transfer of weight). But why Orozco's work fascinates me, is in the artwork of him rolling his body weight in clay down a street, is the incorporation of object bits, dirt and dust. Orozco shows a conceptual and physical transfer, in which his body weight in clay replenishes (by way of the bits and dirt) what his physical body is surrendering or loosing. Aslo assoicates to my mind to the Theory of the Derive (Bopsecrets.org. 2014)

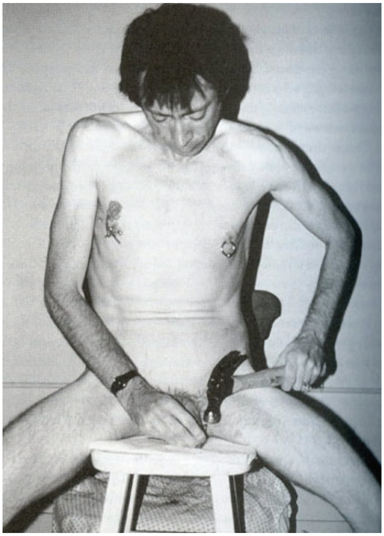
Gabriel Orozco
Yielding Stone
1992
(Bombmagazine.org 2014)



Marcel Duchamp
Large Glass: The Bride Stripped Bare Before the Bathelors Even
1934
(Tate.org.uk 2014)

What the following images have in common and triggered my attention, is the role of the body in the artworks mentioned. As in the body text, this work, *Three Standard Stoppages* by Marchel Duchamp (who drops a metre of string), speaks to the (performative) act of dropping and interfering; artists as the conductor of the experiment. He (Duchamp) Performed the test. Whereas with Bob Flanagan, an artist who pushes the emotional barometer, testing or brushing up against the parameters of the pain threshold; implementing the body as the tool that measures.

Marcel Duchamp
3 stoppages etalon
(3 Standard Stoppages)
1913–14, replica 1964
(Moma.org 2014)



Bob Flanagan
You Always Hurt
the One You Love
1991
(Jones, A: 1998: 232)

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