Chapter 3

In Principle

'The value of a principle is the number of things it will explain.' So wrote the great mid-19th Century American poet, essayist and philosopher, Ralph Waldo Emerson. Although it perhaps doesn't seem like the most thrilling way to set out on our journey along the dimensional trail, if we can just nail some of Dr Abbott's main geometrical themes early on they will keep us on track and open up promising vistas as we go. Sticking close to our faithful guides Reason, Logic and Simplicity, a bold and exhilarating adventure beckons...

Thomas Paine, a leading figure of the Enlightenment, observed in his 1794 work *The Age of Reason* that, '*Man cannot make principles; he can only discover them.*' Whilst Samir Okasha, lecturer in Philosophy at the University of York observes, '*However much the science of the future can explain, the explanations it gives will have to make use of certain fundamental laws and principles.*'[a] The question we therefore need to ask is: *Do phenomena follow predictable rules?* Edward Witten, considered by many the most brilliant mathematical physicist of his generation, said in an interview,

> *"Most people who haven't been trained in physics probably think of what physicists do as a question of incredibly complicated calculations, but that's not really the essence of it. The essence of it is that physics is about concepts, wanting to understand the concepts, the principles by which the world works."* [b]

The idea of the principle lies at the very base of human enquiry. Those I have distilled out from *Flatland* and attempted to crystallise here are not quite as imposing or inaccessible as they may at first appear when listed so starkly as I am about to (and you certainly *don't* have to memorise them) but they are fundamental to everything that follows. Later on we will send them out into the world, deploying them to great effect.

Flatland Dimensionality

We have in our hands a very reliable document, because this amazing and unique tale of *Flatland* by Edwin Abbott Abbott was described by Isaac Asimov as, '*The best introduction one can find into the manner of perceiving dimensions.*'[c] Written so long ago yet still in print, the dimensional principles enshrined within *Flatland* are critical because they define the relationship of one dimension to another in such a way as to provide us with a consistent and practical road-map of the bigger picture – which is part of what mathematics does in general. Edwin Abbott Abbott has already laid them out – all we have to do is identify and make use of them.

In the last chapter we identified two basic dimensional principles which I termed the *Principle of Stacking*[d] and the *Principle of Character*[a], but there are more. I will expand briefly on each as we go, beginning with...

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[a] Samir Okasha, *Philosophy of Science: A Very Short Introduction*, Oxford 2002, P54

[b] "Edward Witten" interview, *Superstrings: A Theory of Everything?* (1992) ed. P.C.W. Davies, Julian Brown, from https://en.wikiquote.org/wiki/Edward_Witten - Accessed 18th June 2017

[c] EA Abbott, *Flatland*, Foreword by Isaac Asimov, Signet Classics 1984

[d] *The Principle of Stacking:* Each dimension is composed of an indefinitely high number of cross-sections (slices) of the dimension below, stacked together and fused into a single entity.

The Principle of Extension:

Each dimension is an extension in a new direction of the one below.

A line has one dimension: length. It is therefore 1-Dimensional. If we add a new direction, width, it becomes 2-Dimensional: a plane.

Note that it makes no difference what we call the new direction. We can begin with a line and add height instead of width and we still get a 2D plane because there is no such thing as 'up', or 'along.' The name of the new direction is irrelevant because two directions make 2D. The usual terminology for directions is 'degrees of freedom' because the number of movement options denotes the number of dimensions. So, if we add a third direction we get 3D. If we add *another* new direction, we get 4D.

Moving on…

The Principle of Inclusion:

Each dimension includes all the ones below.

This is perhaps the most obvious of the principles I list here but, the thing is, a dimension's inclusion of all those dimensions below itself means it actually *comprises* them. In other words, the 3rd Dimension (for example) is *made up of* the 1st and 2nd Dimensions plus the 3rd. This principle will be useful when we come to consider time, which, although conveniently thought of (in a kind of shorthand way) as the 4th Dimension, actually *comprises* space as well.

Next…

The Principle of Accessibility:

Each dimension sees and may influence all those below.

This really shines out from *Flatland* – the clarity with which *Sphere* was able to see and interact with *A Square* from his own dimension of Spaceland. He could even touch *Square's* insides! In precisely the same way, *A Square* could clearly see the *King of Lineland's* line, and of course poor little *Point* was in full view of all – a truly naked singularity.

But now we come to something very interesting about the way in which dimensions are experienced that is perhaps not immediately obvious:

The 'Edge-On' Principle:

Each dimension is viewed from within itself one dimension lower.

We tend to assume that *A Square*, as a 2D being in a 2D world, could see the 2nd Dimension 2-Dimensionally. However this is not the case. Although each dimension sees all those below, *it does not experience itself in the same way*.

Put yourself in *A Square's* metaphysical shoes for a moment and try to imagine his world from his viewpoint: he lives in a flat environment. But he is flush with his surface, therefore everything he sees is

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[a] *The Principle of Character:* Once the stacking of a dimension is complete it assumes a whole new character. Its individual cross-sections fuse together and their discrete nature becomes indiscernible.

edge-on, i.e. *a line*. He only sees lines, all around him, lines of varying length. In other words, *he lives and moves in a 2D world but everything he sees is 1D*. It takes *Sphere* to actually see Flatland for what it is, using his extra dimension of height to look down from the dimension above.

In the book *Flatterland*[a] by mathematician Ian Stewart, his lead character Vikki makes this discovery… *"Well – look, actually old [A Square] saw the Circles edge-on…"* Unfortunately she gets told by her guide *"Don't be pedantic."* So that's that. But this simple observation may hold enormous implications for the real world in which we live, to which we shall return in more depth in a later chapter. Meanwhile we will just pop the concept of the 'edge-on' view into our back pockets, to wield like a trusty penknife on the trail.

But what about the higher dimensions – how easy is it to look up? Attempting to look up is not so simple for the denizens of *Flatland,* because a higher dimension is not merely invisible, or indiscernible, but inconceivable! This is strictly one way traffic. With one very important exception…

The Principle of Cross-Sections:

A lower dimension can experience higher dimensions only in cross-section as they pass through in consecutive slices.

This is the only way in which a lower dimension can see a higher. *Flatland* demonstrates this truth so well, because the lower dimension dweller simply cannot see any higher dimensions. It is not possible. This is why physicists and new agers all disagree on the number and nature of higher dimensions, because – whether their means of access is via calculation or revelation – to a great extent they are all guessing. As Abbott describes, to be discernible the higher dimension must exist as an aspect of the lower. Here is how *Sphere* explained this cross-sectional principle to *A Square*,

> *"Do you not remember, I say, how, when you entered the realm of Lineland, you were compelled to manifest yourself to the King, not as a Square, but as a Line, because that Linear Realm had not Dimensions enough to represent the whole of you, but only a slice or section of you? In precisely the same way, your country of Two Dimensions is not spacious enough to represent me, a being of Three, but can only exhibit a slice or section of me, which is what you call a Circle."* [b]

Should the lower dimension-dweller find himself in the presence of a slice of an entity from a higher dimension which has cross-sectioned into his world, *he will perceive it as part of his own world*. Although the slice is part of the dimension above, it also has the option to be part of the dimension below, or indeed *any* dimension below, by cross-sectioning.

Clearly the slice is not the whole, and may not even remotely resemble the whole, and any attempt to deduce the whole from the slice will be like trying to work out the shape and personality of a pig from the ham in your sandwich!

The lower will perceive the cross-section as part of his own world but – as the little Victorian book shows – the higher entity *may or may not* restrict itself to the universal laws of the lower dimension. In fact it will be more natural for it to obey the laws of its own dimension, and the lower may interpret the higher as behaving strangely or without logical explanation. *"Fool! Madman! Irregular!"* was *A Square's* reaction when he got his tummy poked from the inside.

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[a] Ian Stewart, *Flatterland*, Pan Books 2003, P58-59

[b] *Flatland* Ch16

Reflection… So, what is the lower dimensional being to do? Well, nothing. If he or she is to have any contact whatsoever with higher dimensions the initiative lies squarely with the higher. This phenomenon may hold logical implications for what we mysteriously refer to as spirituality, which we will briefly consider later on.

Something to bear in mind here is that although 'cross-section' and 'slice' are useful terms to express this principle, as we ascend the dimensional ladder cross-sections will no longer be 2D, therefore no longer flat. It's not easy to get one's head round some of these ideas as we move between dimensions, but they certainly do seem to open up some fascinatingly logical windows on how reality functions.

EA Abbott uses imaginary conscious beings to illustrate the relationship between dimensions because it helps us get our heads round the geometry, but as far as the 1st, 2nd and 3rd Dimensions of our own universe are concerned consciousness is clearly not an issue, and we will look at possible reasons why later on. However, the *Principle of Cross-Sections* still very much applies.

Cross-sectioning is a subject with awesome implications which will loom large as this book progresses – I'm well aware that geometry isn't the most riveting subject on the face of the Earth, but stick with it and hopefully your patience will be rewarded! Now we come to one of the most important keys…

The Principle of Relationship:

Whatever is true of the relationship between two adjacent dimensions is true of the relationship between *any* two adjacent dimensions.

In other words, because of the consistent nature of the structure, anything that happens between any two adjacent dimensions can be extrapolated right up or down through the whole dimensional configuration. *"In precisely the same way"*, as *Sphere* said to *Square*, as he illustrated the interactions between Dimensions 2/3 using Dimensions 1/2. This is massive, and it is beautiful. It hands us a key with potential to unlock the whole structure. *Why?* Because some things are more obvious between some dimensions than others. Perhaps this principle should have come first, but the fact is I'm not listing them in order of importance because, well, who can say which of the principles should come before another? They are all indispensable.

So, applying this principle, if we can establish that something is true between, say, the 2nd and 3rd Dimensions, then because of the way that inductive dimensions fit together we can discover things about the way things work between *any* two dimensions which would perhaps not otherwise be obvious. This shows the power of mathematics to uncover hidden relationships in nature, because it is clear to us that in *Flatland* the way the sphere interacted with the plane was exactly the same as the way the plane interacted with the line.

All this is pretty obvious in terms of Dimensions 1, 2 and 3, but what of Dimensions 4, 5, 6 and beyond..? If the principle holds good all the way up, we may be on to something. It clearly does, at which point our road-map turns to satnav!

Flatland v Reality

Like a motor car engine, a suspension bridge or a bird's wing, all the parts must be in place and working or the whole system fails. Without all its functioning parts, a dimensional structure becomes a

meaningless collection of useless bits and bobs. Therefore one cannot skip dimensions, because each is built upon, and *from*, the one before. Let's just solidify this in another principle…

The Principle of Completeness:
The dimensional structure functions as a single inter-dependent whole.

The whole dimensional structure is an example of irreducible complexity, where to remove one part would be to cripple the whole. Some things in life are like that – others are not. As an example of something that is complex, yet not irreducibly so, you could still enjoy a stew even if you forgot the onions. It might not taste so good, and the world is no doubt full of chefs who would categorically refuse to cook a stew if they didn't have onions, but under normal circumstances no-one would miss dinner. Life may seem pretty mixed up most of the time, but Dimensionality is not a stew. This is what makes it so intriguing, because here we all are stuck somewhere in the middle of all this wonderfully balanced mathematical precision, and most of the time we don't even know it!

Now we'll take a look at how the dimensional structure builds. Let's begin by asking… *What happens when you take the three dimensions of our world, and stack them up?*