

## Chapter 45

### Escape from Flatland

Earlier, in Chapter 16, we looked at how the concepts of 1D lines, 2D planes and 3D 'invizicubes' are not descriptions of what the dimensions *are*. Instead they are simply geometrical representations which work mathematically because the universe works mathematically.

Relativity describes how the 4D continuum behaves from our physical viewpoint, but if we consider that a *Flatland*-based geometry has the 4th Dimension obeying all the same geometrical principles as the lower three (see Chapter 11) it follows that, from the 'outside', we see four dimensions of differing character and ascending complexity.

Consequently, instead of asking:

- 'Why are there three dimensions of space and one of time?'

we ought to ask...

- 'Why do we experience the dimensional structure from this particular viewpoint?'

To attempt an answer to this question we must return briefly to Flatland.

### Life on the Edge

Although we may describe the 2-Dimensions of *A Square's* world in line/plane terms as length and width, this is just one way in which to represent them. As usual, all is not as it seems on that simple little flat surface...

As previously described, the Flatlander views his world edge-on<sup>a</sup> as a 1-Dimensional line – actually, a 1D circle that encloses him at zero distance from his perception. In the language of mathematics this would be described as a 1-manifold in 2-space, which we defined in Chapter 9 as follows: *A Square* is...

- 'hemmed in by a continuous circle of confining 1-Dimensionality with no beginning and no end'.

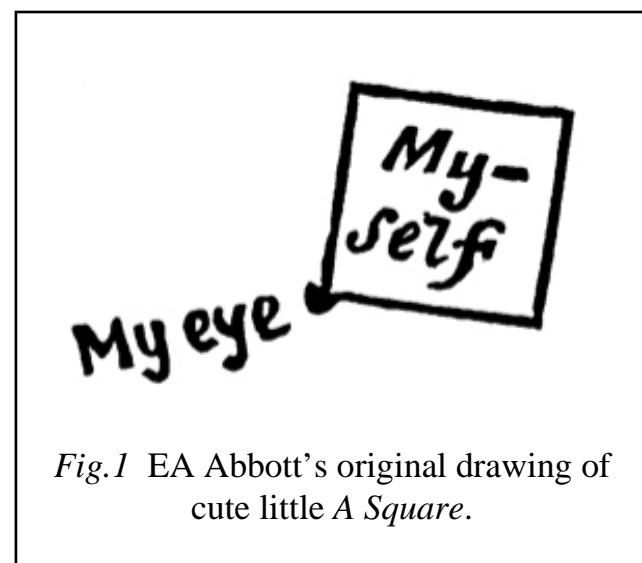


Fig.1 EA Abbott's original drawing of cute little *A Square*.

Crucially, his second degree of freedom (which EA Abbott termed width) is not physically visible to him. Therefore, from his viewpoint, another equally valid way to express his condition is as follows:

- 1) He may decide on a direction to face, and
- 2) He may move in that direction.

His decision which direction to face is taken on the basis of how his circular 1D world is experienced by him – in other words, by the *perception of his senses* he considers his world and plots a course. As he does so, the range of sensory information coming at him from his circumstances changes. From *A Square's* viewpoint it is not a question of 'length' and 'width'.

His world changes.

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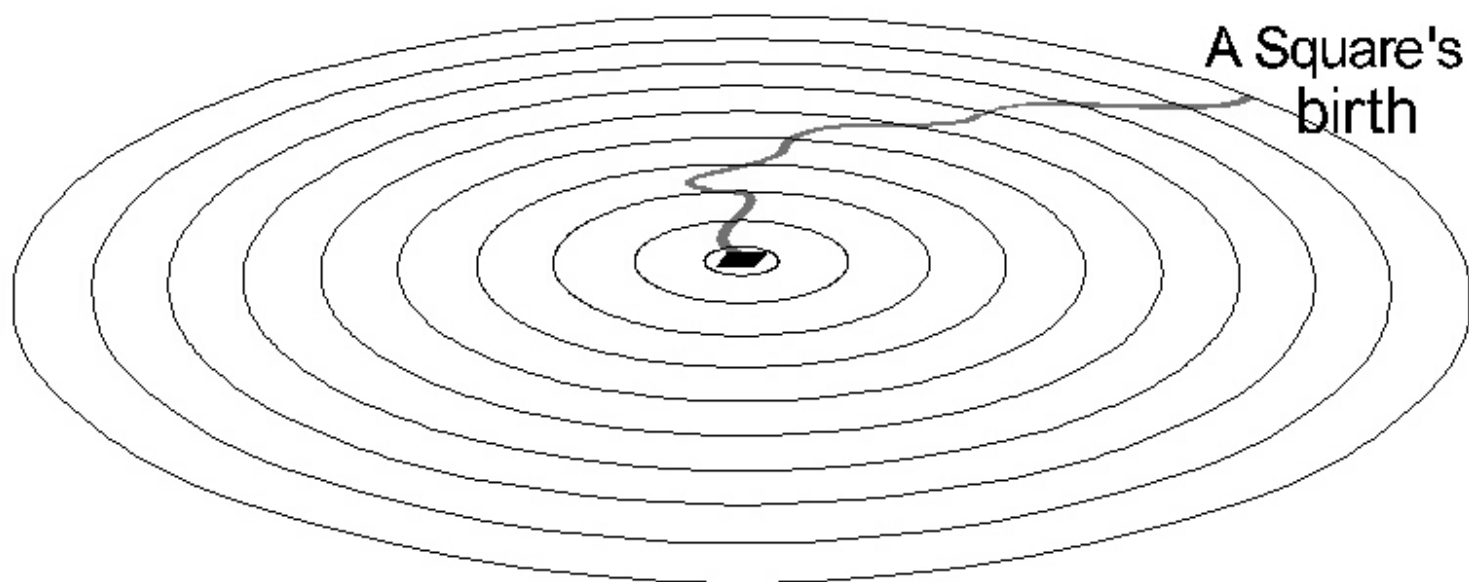
<sup>a</sup> *The 'Edge-On' Principle*: Each dimension is viewed from within itself one dimension lower.

## Time, in 2D

*Flatland* was written in 1884 – several decades before Einstein, Minkowski, Lorentz and others gifted to the world their understanding of the nature of 4D space-time, wherein the 4<sup>th</sup> Dimension behaves temporally. Extrapolating this scenario downward we find that, rather than simply a flat surface of two spatial directions (as might appear dimensionally from above), to *A Square* Flatland is actually a 2D space-time.

In 2D, *A Square* views his world as a 1D circle around him whilst – as he moves around – his 2<sup>nd</sup> Dimension is the means by which his 1D world changes. Although he knows he lives in a 2D *universe*, his 2nd Dimension is invisible to him, acting solely as his means of change. This ‘means of change’ is his temporal dimension. He knows this primarily from the way in which he and all those around him *feel* themselves pushing through their all-encompassing circles, ‘refreshing’ them constantly like computer screens. Although his 1D *viewpoint* remains the same, his 2D *circumstances* continuously change. This is the way the Flatlander experiences his two degrees of freedom giving him awareness of the 2-Dimensionality of his universe. (Granted it’s not much of a life, but then he is made-up.)

In terms of the magic treadmill<sup>a</sup>, described in Chapter 11, *A Square’s* 1D spatial experience is jammed up at zero distance against his perception, whilst his 2D temporal experience points away from him radially like the spokes of a cartwheel. His 2<sup>nd</sup> Dimension flows away from him in an ever-widening circle, emanating radially from the point-event at which he is located in a constant flow over which he has no control<sup>b</sup>. The future continuously washes through his now-experience, radiating away like ripples on a pond into the (to him) invisible 2D beyond, there solidifying on the Flatland surface into an expanding disc which he confidently refers to as his past. This disc has his birth event on its perimeter and his now experience always at its centre.



*Fig.2* The squiggle is *A Square’s* world-line. It represents his whole life so far as his 2<sup>nd</sup> Dimension (time) emanates from the point at which he stands. At any given point on the line he was at the centre of a smaller set of ripples, and the point’s position on the circle depends on the direction he chose to face at the time.

<sup>a</sup> *The Magic Treadmill Principle*: Time, as the  $n$ th Dimension in an  $n$ Dimensional space-time, issues forth perpendicularly and radially from within the frame of reference of each space-time event. To the observer this  $n$ th Dimension appears 0-Dimensional (is viewed 'point-on') and is therefore invisible, but results in  $(n-1)$ Dimensional change, and stacking of the  $(n-1)$ D surface into the  $n$ th Dimension, taking the form of the past.

<sup>b</sup> Due to the continuous stacking of his 1<sup>st</sup> Dimension into his 2<sup>nd</sup>, an axiom we accept in the same way that we accept in our world the passage of time.

*Reflection...* We talked earlier about the ‘arrow of time’ which describes how time moves inexorably forward – like a boat on water – from the past into the future. However, when we use the phrase, the ‘passage of time’, we are implying that time is passing – like the water along the boat – from the future into the past (passed). All that these two contradictory analogies are really saying is that ‘from our viewpoint, time *appears* to move’, because change takes place. If we examine the Flatlander’s experience we see his changing world is not the result of movement, but stacking up of his 1<sup>st</sup> Dimension (the circle jammed against his perception) into his 2<sup>nd</sup> Dimension (the disk).

## A Literary Complication

There arises somewhat of a discrepancy in this picture to the way it was presented in *Flatland* the book due to EA Abbott’s 19<sup>th</sup> Century inability to discern the role of time. Dimensional principles express the deep relationships between things and we must allow them to differentiate between 'Flatland the imaginary place' and 'Flatland the dimensionally consistent world'. If *A Square's* world extends across the sphere-surface<sup>a</sup> of his universe into his 2nd Dimension, then it is extending away into time rather than space, as his real universe widens into the Flatland past. So, anyone standing near him on that 2D surface is separated from him not merely by space, but by a period of time.

Each Flatlander experiences the universe as ‘observer-centred’. As he views his confining 1D circle (which is jammed against his perception at zero distance) he is gazing out upon a 1D snapshot of his unfolding 2D reality, a single ‘now’ cross-section which constitutes his 'observable universe'. Does this sound familiar? *A Square's* circular 1D horizon is the equivalent of the entire 3D contents of our 'light sphere' except that, down two dimensions from us in Flatland it becomes a 'light circle'. But, like us he must await the arrival of visual information at the speed of light as it whizzes to and fro around his periphery – which to him is space – and say goodbye to all the visual content of the moment now as it passes at light speed from his future into his past.

Note that, in this situation, the speed of light has absolutely nothing to do with light. We haven’t even specified a need for the photon’s existence in this purely geometrical world. Instead ‘lightspeed’ for the Flatlander is simply an arbitrary finite speed at which information passes along both his degrees of freedom.

Again Flatland shows us in a beautiful geometrical microcosm precisely what we humans see, but two dimensions lower, because the 1D and 2D aspects of his universe correspond to our 3D and 4D aspects. And, like us, *A Square* will have to be careful not to confuse the two when he is teaching his children. We must remember that the flat spherical surface of Flatland, which is invisible to the Flatlander as it extends away from him is, for him, the whole of space *and* time. *It is not his observable universe, but his block universe.*

## Mind-Mapping

If *A Square's* world can be said to be flat (as we would say it was), he can never see it in this way because he can never view the flatness of his world directly, i.e. spatially. It may only be perceived as 2-

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<sup>a</sup> For a fuller (and entertaining!) description of Flatland as the surface of a sphere, see *Sphereland* by Dutch mathematician Dionys Burger: a 1965 ‘update’ to *Flatland* in the light of Relativity. (Dionys Burger, *Sphereland*, Harper & Row 1983)

Dimensionally spatial to us because we are 4D, or to *Sphere* because he is 3D – *Sphere* and me enjoy the perspectival privilege of viewing it from above.

However, in spite of this apparent handicap, because *Square* is a living being rather than, say, a rather fetching coffee table, as he moves around he is able to build up a mental picture of his surroundings. In his mind he processes all the 1D liney-type information from his physical senses along with his relentless treadmill over time's 2D point source producing change, into an inner visualisation of the layout of his world over time. In this way, *conceiving of his world from above*, he overcomes the limitation of his physical edge-on view, superseding it with a bird's-eye view which populates his imagination with all the triangles, hexagons and virtually perfect circles that so cruelly dictate he and his wife's social status in *Flatland*.

Because his universe is 2D, for the Flatlander this overview takes two distinct forms:

- 1) In his mind's eye he feels that he can see the *whole* of his 1D circle because he is able to retain an image of the bits (e.g. behind him) he is not currently looking at, and
- 2) He also retains in his mind's eye an image of the receding circles as they treadmill radially away from him into his 2<sup>nd</sup> Dimension, which is his past.

The first is his visualisation of his immediate space (his circle) and the second is his visualisation of time past (the expanding disc). In this way he forms a fleshed-out picture of his life that bestraddles both dimensions. (His picture is of course subjective and incomplete – not a 'God's eye view' as such – because it consists only of those parts he chooses to focus on.)

The Flatlander's cerebral ability to mind-map his world is something that exists in some way 'above' the Flatland plane, otherwise he would not be able to visualise the layout of his world and the shapes all around him, so in a sense *Square* does not need *Sphere*, because inwardly he already sees what *Sphere* sees. *Square's* mental picture of his world, whilst not being a direct experience of his 2D universe like *Sphere's* in the book, is nonetheless the expression of an ability to visualise and comprehend the 1<sup>st</sup> and 2<sup>nd</sup> Dimensions from one uniquely 'roving' viewpoint. Metaphorically his mind sends out a little dimensional drone equipped with a camera which gives him a fuller picture of the 2D layout of his space-time.

From this we can clearly see that within *A Square's* mind he is actually able to 'look down' upon his world. However, as the experience of *Sphere* demonstrates, the geometry tells us that ***this is something that is only possible from a dimension above***. Let's look again at one of the principles drawn in Chapter 3 from *Sphere* and *A Square's* experiences in *Flatland*:

*The Principle of Accessibility:*

**Each dimension sees and may influence all those below.**

So, by the logic of *Flatland* geometry, if *A Square* has awareness of the layout of his 2D plane, his imagination is operating from a dimension above, and therefore, since we cannot skip dimensions<sup>a</sup>, his mind must be operating from a 3<sup>rd</sup> Dimension.

Summing up, we may therefore conclude that the Flatlander:

- Senses in 1D
- Experiences in 2D
- Imagines in 3D

Not bad for a little chap who a few moments ago was just flatguy from flatworld!

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<sup>a</sup> *The Principle of Extension:* Each dimension is an extension in a new direction of the one below.

By describing the dimensionality of *A Square's* world we have now established in principle a *direct geometrical link* between the Flatlander's spatial and temporal experience, and his mind. Indeed, this mental picture is what constitutes his 'life'. It perhaps cannot account for how he *feels* about his life, but it certainly covers his basic cognition of the physical side of all that exists and happens around him.

It turns out that the Flatlander is not merely a '2-Dimensional being' after all – he is instead a *composite dimensional being*. And it is the smooth interplay between these (in his case) three dimensions that energises his world.

## Sweet Memories

But *A Square's* ability to mind-map also acts as his memory, because without the ability to visualise the physical and temporal layout of his life he would never be able to recall the existence of anything at all, and, like Drew Barrymore in the Adam Sandler film *50 First Dates*, every day would be news to him! Indeed, every moment would be news to him. US psychologist Kenneth L Higbee tells us,

*'Without memory we would have to respond to every situation as if we had never experienced it. The value of memory is also shown by the fact that we reason and make judgments with remembered facts. In addition, we are able to deal with time, relating the present to the past and making predictions about the future... Even our own self-perceptions depend on our memories of the past.'*<sup>a</sup>

If the Flatlander had no ability to overview his sequence of past now's, he would experience only an eternal present, utterly devoid of context. Even the positions of walls and doors would be an unrecalled mystery and he would just bump around like a rice crispy in a plate of milk.

An important aspect of *A Square's* experience of the present is his ability to visualise futures. Informed by his bird's eye view of his 2nd Dimension, he is able to conceive a range of potential future scenarios – from his retirement plans down to his very next step – which have his previous experiences to inform and guide them. Indeed, his visualised futures consist *exclusively* of rearranged past experiences, because these comprise the totality of the knowledge on which he may draw. Clearly there are a wide range of cognitive abilities which are tied directly to the Flatlander's ability to mind-map, which is in turn related to the geometry of *Flatland*.

*Reflection...* Interestingly – and we will look at this in more detail in Chapter 58 – the idea of the Flatlander as a composite being has not required us to think of his memory as a storage/retrieval facility. Because of this theoretically straightforward geometry, Occam's razor might suggest that the simplest interpretation of *A Square's* ability to think and memorise is ***by the direct act of scanning his 2<sup>nd</sup> Dimension from one dimension higher***. His 3D memory-drone is a slick and fast live transmission from wherever it is sent, not a librarian who laboriously fetches and carries books from some gigantic *Amazon* storage facility in his brain.

Indeed, the existence and function of a 'brain' does not require to be specified at all in a purely geometrical world and can only complicate the picture if it is.

Now let's extrapolate...

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<sup>a</sup> Kenneth L Higbee, *Your Memory: How it works and how to improve it*, Piatkus 1989, P16