Wandering Towards a Goal: How can mindless mathematical laws give rise to aims and intention? Richard Conn Henry

The short answer is that mindless mathematical laws cannot, and therefore that they do not, give rise to aims and intentions.

How is it that human history can lead to an essay contest on the above theme? And what does that choice of theme tell us about ourselves today?

It tells us that we are intellectually still young indeed—that we still do not know what the right questions are, though (even so) we have made many wonderful strides toward eventual answers. For please do remember that it was only about 50,000 years ago, in East Africa, that we humans even developed spoken language. That happened with the appearance of the FOXP2 gene, in one small group of humans, giving them (well, giving us—for the rest of the million or so people then on Earth left no descendants) the incredible gift of speech: the ability to symbolically represent both things and ideas.

The ideas were there already, inchoate—for example, people over the ages looking at Venus in the western sky after sunset! I was a guest, long ago, in Western Samoa, and I said to my host, "Tapui T'ear." I had learned that from a friend who had visited Western Samoa years before. My host turned, and he looked into the western sky: Venus! What is Venus?

Marcus Aurelius thought that the stars were gods—so, perhaps, did pre-FOXP2 humanity.

We humans are not very smart, for how can it be that our most brilliant ancient civilizations—those of India, China, and some others—failed to find the magic key to our present intellectual explosion: that key being mathematics (yes, mindless mathematical laws) mapping astoundingly to our perceptions of what we call the universe?

How could it be that, instead of being the fruit of those ancient and most glorious civilizations, the truly magical and liberating connection appeared and took fire only amidst the chaos of horrible primitive medieval Europe?

Newton modestly (and correctly) said that he stood on the shoulders of giants: yes indeed of Galileo, but Newton really was referring to the tag-team of Tycho Brahe and Johannes Kepler: the fantastic conjunction of Tycho, a builder of giant celestial observing devices—and, more, the user of same to pursue Mars relentlessly—working with a human mathematical machine, Kepler, a man of incalculable ability and persistence. Kepler worked directly with Tycho, and after Tycho’s death used Tycho’s data to pursue Kepler’s own (and quite wrong) ideas about the mathematical structure of the solar system. Kepler died without understanding what his true accomplishment was—it took Newton to extract it from Kepler’s work and thereby open up the physics of today: the advent of our wonderful but mindless mathematical laws.

Above, I criticized the theme of this contest. But now let me withdraw that criticism, simply because of the marvelous opening phrase of our theme: "wandering towards a goal." The realization of ignorance is the beginning of wisdom. I have mentioned how Kepler, supreme genius, wandered incorrectly, yet achieved greatness; well, Newton, too, wandered incorrectly, but he also, like Kepler, achieved success despite the falsity of his core beliefs—for Newton was flabbergasted and repelled by the success of his own law of
Wandering Towards a Goal: How can mindless mathematical laws give rise to aims and intention? Richard Conn Henry

gravitation, which was nothing but a tiny formula, entirely lacking in the mechanisms that Newton sought.

The problem that Newton had, and that too many of us today still have, is the incorrect notion that mathematics is just a tool that is useful for exploring a physical universe. But what "physical" means is not defined—it still today has no meaningful definition. A common word that is used is "real." Well, there is no "real."

That is the heart of my essay. The world is not real—it really is not. The world is mental, not physical. Physical has no meaning. Arthur Stanley Eddington knew that, and Sir James Jeans knew that. In 1990 I published my essay in Nature, "The mental universe," an attempt to revive Eddington and Jeans' pioneering proposed intellectual basis for us to proceed more successfully with our investigation of that which we call the universe.

What does it matter that the world is not real? It matters because until one grasps the, well, reality, of that idea, one cannot most effectively work towards the goal: if you don’t know the rules, you will not play the game very well. Of course most people do not know the rules, yet they nevertheless do achieve some successes. That is because most other people have the same blindness and thus go along with what is in fact a naïve approach to the universe. We would be much better off should we adopt a, well, again, realistic, approach to our study of the universe and of ourselves. We ourselves, unlike the universe, are real.

Let’s look at a sequence of "case studies" of my theme, which I expect will convert you—starting with the Pythagorean theorem, which is the most fundamental key of all:

Notice that this proof of that most famous theorem does not involve any mathematics at all: we simply see the truth of the theorem, as a property of that which we call the external world. My aim and intention with this figure will give rise to mathematical laws—first of all, to the "plane ordinary" Pythagorean theorem, \( ds^2 = dx^2 + dy^2 \).

That equation is a mental human construct—it was devised in Italy during the fourteenth century to represent the already-known, from nature, Pythagorean theorem.
Wandering Towards a Goal: How can mindless mathematical laws give rise to aims and intention? Richard Conn Henry

Fast forward now to the nineteenth century, and to William Rowan Hamilton, that supreme genius of physics and of mathematics, the inventor of quaternions (now vectors), by which invention Hamilton showed that the great Gauss was wrong when Gauss claimed (in 1830) that "we must confess in all humility that, while number is a product of our mind alone, space has a reality beyond the mind whose rules we cannot completely prescribe." Well, Hamilton was indeed a genius—yes indeed; but genius does have its limits, as we shall now see!

For Hamilton tried to extend the Pythagorean theorem to encompass time as a fourth dimension: and our "supreme-genius-of-physics-and-mathematics" Hamilton failed utterly in his attempt—a huge embarrassment in retrospect, but one that illuminates the core weakness of our human minds. Understanding that illumination of our weakness is of immense value in trying to remove the blindness today exemplified in our contest theme.

How do I know that Hamilton tried and failed? I know it because (bless him) Hamilton wrote the following poem revealing his abject failure:

THE TETRACTYS by William Rowan Hamilton

Of high Mathesis, with her charm severe,
Of line and number, was our theme; and we
Sought to behold her unborn progeny,
And thrones reserved in Truth's celestial sphere:
While views, before attained, became more clear;
And how the One of Time, of Space the Three,
Might, in the Chain of Symbol, girdled be:
And when my eager and reverted ear
Caught some faint echoes of an ancient strain,
Some shadowy outlines of old thoughts sublime,
Gently he smiled to see, revived again,
In later age, and occidental clime,
A dimly traced Pythagorean lore,
A westward floating, mystic dream of FOUR.

I put this forward not to shame Hamilton's ghost but to encourage every reader of this essay: the great Hamilton (and he was indeed great) was subject to an utterly naïve prejudice: Hamilton could not bring himself, in place of

\[ h^2 = a^2 + b^2 + c^2 + t^2 \]

to write, and to explore

\[ h^2 = a^2 + b^2 + c^2 - t^2 \]

The latter, of course, is Einstein's 1905 Theory of Special Relativity, complete. Had Hamilton explored that (in retrospect obvious) possibility, then with Hamilton's mathematical ability there is no question that he would have anticipated Einstein. And indeed, Einstein himself was just as blind as was Hamilton—it was only Einstein's teacher,
Wandering Towards a Goal: How can mindless mathematical laws give rise to aims and intention? Richard Conn Henry

Hermann Minkowski, who finally realized exactly what Einstein's two original (and pathetically naïve) "postulates" actually implied about the inner nature of time.

Careful now, dear reader: don't make the terrible mistake of accepting the result but missing the point: we must analyze the result, in detail, to grasp its huge implications—not for the universe, but for our own minds.

Geometry is a human invention: possibly originally created simply to re-establish land boundaries after the annual flooding of the Nile? That early mathematics was, much later, expanded by Italian mathematicians to encompass algebraic equations. And now, post-Einstein, abruptly, through the mind of Minkowski in 1908, revealed to allow human access to the secret of the nature of time itself, through Minkowski's $h^2 = a^2 + b^2 + c^2 - t^2$

That single, simple, equation contains the most important physics we have ever discovered. We are looking for meaning in this essay, not just technical answers to questions! So let me persist: if we insist, as we usually do, on $t$ in our equation being expressed in seconds, then we must multiply $t$ by some number $c$ to convert it to meters, so as to have our equation be consistent. But what is the numerical value of the required units-conversion factor $c$?

By experiment (a clock flown at high speed around the world, and the time taken, as measured aboard the moving plane, compared with the (supposedly) same time taken, but as measured with an identical clock that had been left behind on the tarmac) the numerical value of $c$ was determined to be very close to $c = 299,792,458$ meters per second—recognized of course as the known speed of light.

So, today, we usually choose to write

$$h^2 = a^2 + b^2 + c^2 - (ct)^2$$

or, if we also decide to write, for the separation in space-alone of two events (say, of two snaps of my fingers, as I wave an arm about)

$$d^2 = a^2 + b^2 + c^2$$

then we are able to more compactly write

$$h^2 = d^2 - c^2 t^2$$

That tiny "Pythagorean" equation is—complete—Einstein's theory of relativity: all else, including $E = mc^2$ and the atomic bomb, can be deduced from it (after multiplying through by $m^2$) using nothing but the magic—and I use that word advisedly—of our human-invented algebra. (For the reader's students I provide my proof in the APPENDIX.)

But wait—algebra is indeed a human invention—and indeed, is a recent human invention.

Why should algebra, which was invented by us, produce a prediction of the atomic bomb? Yet, algebra does! We have no idea why—but it is so.
Our “Pythagorean” equation now easily shows us that "photons of light" are but a, dare I say, “white lie” of the physicists (though still a useful tool for students and for engineers): for if, instead of our two events being two snaps of our fingers at different times and locations, we choose for our two events:

Event #1, a photon of light is created on the sun and heads toward Earth; and,

Event #2, 8 minutes later, that photon arrives at Earth, and is absorbed in a retina

then in that case $d$ is the distance from the sun to the Earth, and $t$ is the time taken by the photon in going from the sun to your eye.

Now, of course distance is equal to velocity times time: $d = v \cdot t$. Substituting that tiny new equation into our red relativity equation gives

$$h^2 = v^2 t^2 - c^2 t^2$$

where $h$ is the separation in space-and-time (that is, in our universe) of the two events: the birth of the photon on the sun, and the extinction of that same photon, in generating an electrical signal in the eye of some person on Earth.

We have reached the crux: the speed $v$ of a photon of light is, by experiment, $c$ meters per second. Setting $v = c$ shows that the separation in our universe between the two events of a photon’s birth, and of that same photon’s extinction, is

$$c^2 t^2 - c^2 t^2 = h^2 = 0$$

So in spacetime—that is, in our universe—there is no separation at all between the two events: thus our supposed photon can have no existence. Between its emission on the sun and its reception on Earth, the photon is most definitely not "out there and on its way."

“All these fifty years of conscious brooding have brought me no nearer to the answer to the question, 'What are light quanta?' Nowadays every Tom, Dick and Harry thinks he knows it, but he is mistaken.” (Albert Einstein, 1954)

That is a big part of why we get the oddities of the well-known quantum-mechanical double-slit experiment: there simply are no photons—there are only results: which are the measurements themselves.

But wait, there’s more!

Suppose two observers (one moving with velocity $v_1$ and the other moving with velocity $v_2$) witness those same two events: by hypothesis $h$ is invariant, so

$$v_1^2 t_1^2 - c^2 t_1^2 = h^2 = v_2^2 t_2^2 - c^2 t_2^2$$

or $v_1^2 t_1^2 - c^2 t_1^2 = h^2 = 0 - c^2 t_2^2$ if the second observer has $v_2 = zero$

or $v_1^2 t_1^2 - c^2 t_1^2 = - c^2 t_2^2$
Wandering Towards a Goal: How can **mindless mathematical laws** give rise to **aims and intention**? Richard Conn Henry

Look sharply at that last equation!

The square of any number is always positive. So because of the minus sign, the right hand side of the equation is necessarily a negative number. But if $v_1$ is faster than light (that is, if $v_1$ is greater than $c$) the left hand side of that equation would be a *positive* number, which cannot be equal to a negative number. So our equation asserts that velocities greater than that of light simply cannot occur: if anyone says that they can, that would be analogous to someone—absurdly—announcing that they can go north of the north pole.

Our equation produced the atomic bomb—our equation is known to be true: so we conclude that velocities faster than light are not just not possible, they are inconceivable—the 4-dimensional geometry of spacetime simply does not permit it—there simply is no faster.

So light is discovered to go as fast as it is possible to go. As do gravitons and gluons.

If photons do not exist (and we have just seen that they do not) neither in fact do even electrons or any other particles (and this has also been confirmed by experimental tests). So the universe does not exist, except in our minds as experiences. Yes, your mind is real, and yes, the observations are real: but the observations are not observations of anything.

Good physicists are perfectly well aware of this, but it is as mind-boggling to them as it is to anyone, and there is no clear conclusion as to what all of this really means: are we but dreams in the mind of God? Who knows? So physicists generally stick to only—at least in public—discussing a fake universe of things—for why make yourself sound like a fool, even if you know that you are not? To make progress in their physics, all physicists know that they must stick to their equations, because they have learned that only by means of those equations do they get answers that turn out to be correct when checked by experiment.

If the Pythagorean theorem is worked out not in a flat spacetime but in a curved spacetime, its algebraic form changes, of course. And if we apply the same magic that we learned to adopt for time (simply changing the one + sign to a - sign) we quickly get Einstein’s theory of General Relativity.

Curved spacetime—as just slightly patched up by Einstein so as to ensure conservation of energy—was found in 1915 to yield Newton’s Law of Universal Gravitation as its first approximation (but only if a factor of $8\pi$ was stuck in—for, still, no understood reason) and, wonderfully, Einstein’s new theory predicted many since-confirmed effects (including the most glorious recently detected gravitational waves) neither predicted by nor explicable with Newton’s original gravitation: another, and huge, success for Albert Einstein.

Relativity—even in its general form—is a simple theory. It is perhaps very strange, but it is certainly true: true—by the acid test of many experiments. And it helps make clear to us that the universe is a mental mystery.

There is a bigger mystery than relativity or even quantum mechanics: the mystery of the human mind—of its strengths and of its foibles. The human race has produced such as Ramanujan, instinctively superbly mathematical. That suggests that evolution could result
Wandering Towards a Goal: How can mindless mathematical laws give rise to aims and intention? Richard Conn Henry

in instinctive mathematical brilliance in all, in due course. And thankfully the human race need not pay any price for that: the brilliant physicist Arthur Stanley Eddington, for example, was both mathematically supremely gifted, and yet was also a superbly rounded, albeit imperfect, human being.

But even Eddington was unable to think up that magic minus sign—the minus sign that can today easily reveal relativity correctly even to elementary school students. But for that matter, as we have seen, neither did Einstein himself! Instead, Einstein, in 1905, put forward two clumsy postulates, postulates that were not mathematical, but rather were sentences in German. Yes, those sentences did work, despite their clumsiness, but three years later, Einstein’s former professor, Hermann Minkowski, finally did come up with the Pythagorean minus sign that abruptly revealed Einstein’s relativity theory to be most beautiful and natural, rather than freakish and arbitrary.

So what about quantum mechanics?

In my experience, the vast majority of well-educated people who are acquainted with quantum mechanics believe it to be deeply mysterious. Indeed, I recall a revealing talk, before a scientific audience, by Roger Penrose. It is powerful to receive the ideas of luminaries in person, rather than just from their writings, because in person, they say things that they do not, in cold blood, write.

Roger was emotional on the subject of quantum mechanics!

Now, this essay of mine summarizes my personal journey over some decades.

Teaching physics had gradually revealed to me what I have summarized above, and so, happily, it finally dawned on me that quantum mechanics too, must surely be natural, and must be purely mental in its origins.

So, one summer at Los Alamos, I sat down and I said to myself, suppose I just ask, “what is an observation?” Any observation, of anything? The answer clearly was, that when closely examined, any observation is “a number.” That was the launching point for my paper "Quantum mechanics made transparent." As I composed my paper, quantum mechanics appeared, to my great pleasure, automatically, simply from considering numbers, Noether’s theorem, and nothing else. Quantum mechanics was natural, and quantum mechanics was inevitable!

Subsequent (and much more sophisticated) ab initio derivations of quantum mechanics have come to exist: Shapiro (2008).

So let me finally sum up: wandering Towards a Goal: How can mindless mathematical laws give rise to aims and intention: bad question! Laws cannot give rise to anything at all: laws are quantitative abstract mathematical conclusions that can only be drawn from observations and the disciplined power of our minds. Absent observations, minds could only hypothesize conceivable laws. Absent observation, mind has nothing to search for any possible laws. So the entire premise of this contest is hopelessly muddled. But why is that?
Wandering Towards a Goal: How can mindless mathematical laws give rise to aims and intention? Richard Conn Henry

It is clearly because of yearning on the part of those human spirits—those minds—whose “aims and intentions” gave rise to the contest in the first place!

Good for those spirits! They shall be rewarded:

I could propose a follow-up essay contest: **How can aims and intention give rise to mathematical laws?** I would win that contest—indeed, I'll happily show how I'd win it right this minute: it is clear that aims and intentions—conscious spirits—that do not give rise to mathematical laws will be ‘aims and intentions’—that is, minds—that only wander inchoate in—literal—darkness. Only aims and intentions that give rise to mathematical laws will find themselves in a position where they can, for example, launch intellectual contests. Kepler was therefore well-motivated indeed in looking for symmetries—he was simply looking for the wrong symmetries in the wrong places.

It was Emmy Noether who found for us the necessary symmetries—those symmetries that snatch coherence out of chaos and that thereby allow the human mind and that also, necessarily, require that there be a vast and empty universe—with no purpose other than to simply provide the stage on which we humans delightfully prance and dance.

References:


Henry, Richard Conn, additional help for you: http://henry.pha.jhu.edu/trivial.pdf

Shapiro, Moshe, "Derivation of the relativistic 'proper-time' quantum evolution equations from canonical invariance, 2008, J. Physics A: Mathematical & Theoretical, **41**, 175303

(All the web links were verified on 2017 March 07 Tuesday: which was my 77th birthday!)
Appendix: to show that $E = mc^2$

Many readers of this essay, I expect, will be teachers, who might appreciate a transparent derivation of *that most famous formula* $E = mc^2$ from the equally famous theorem of Pythagoras (so trivially—but so consequentially—extended by Minkowski’s improving on Albert Einstein) —

$$h^2 = d^2 - c^2 t^2$$

where $h$ is the separation (in space by $d$; in time by $t$) of any two events, such as the spaceship (redheart) leaving the sun, and arriving at Earth, of my essay. [Of course I ignored gravity completely (I hope you noticed that)—I chose that geography just to establish an easily visualized and accepted great distance.] Here is that trip: $d = dx$ is the distance from the sun to Earth, $t = dt$ the time the trip takes, and the primed coordinate system is that of your moving sister redheart, the unprimed coordinate system being that of Earth.

$$dh^2 = dx^2 - c^2 dt^2 = dx'^2 - c^2 dt'^2$$

That equality is the only hypothesis of special relativity. The hypothesis is that $dh$ is invariant: that $dh$ is the same for you on Earth, as it is for your moving sister, redheart. So the claim is that (slightly reorganizing our equation)

$$c^2 dt'^2 - dx'^2 = c^2 dt^2 - dx^2$$

Our two chosen events are redheart snapping her fingers as she leaves the sun, and redheart snapping her fingers once again as she arrives at Earth. We on Earth have strategically located two carefully synchronized clocks, one on Earth, the other operated by a graduate student located at the sun. $dt'$ is the duration of her journey as measured by her wristwatch, while $dt$ is the same time interval as measured by us, stationary.

Snap test: study the two diagrams again, and tell me the numerical value of $dx'$.
Wandering Towards a Goal: How can mindless mathematical laws give rise to aims and intention? Richard Conn Henry

Right! \( dx' = 0 \) because it is the distance between the two finger-snaps as measured, in her own reference frame, by your sister. She carries that reference frame with her as she moves. The two events take place at the identical location in her reference frame.

Now we launch on a bunch of algebra. It is nothing but algebra: no additional physics, of any kind. (But how does Mother Nature know algebra? No one has any idea, but know it Mother Nature does!) Because in redheart’s rest frame \( dx' = 0 \), we decide to re-label \( dt' \) as \( d\tau \), and so \( c^2 d\tau^2 = c^2 dt^2 - dx^2 \). Her rocket’s speed is \( v = dx/dt \) as measured by us on Earth [and \( u = dx/d\tau \) as measured by redheart herself—the very same distance of course, but (as we shall bring out) a quite different time interval]. So we rearrange:

\[
\frac{dt}{d\tau} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \equiv \gamma = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} = 1 + \frac{1}{2} \frac{v^2}{c^2} + \cdots
\]

That last step is a binomial expansion (invented by Newton). Since normally \( v \) is very much smaller than \( c \), all higher order terms (+ …) can be ignored.

The first part of our equation demonstrates time dilation. If the rocket speed \( v \) (measured from Earth) is zero, our equation says that \( dt = d\tau \) and the time aboard the (stationary) ship is the same as time on Earth. But as \( v \) approaches \( c \), the coefficient of \( d\tau \) approaches infinity, and so \( d\tau \), the trip time as measured by redheart, approaches zero. Time slows down as one approaches the speed of light. And time does not pass at all for a photon! Photons are absorbed and cease to exist the same moment that they are created, according to their own wrist-watches!

Now let’s return to our equation \( m^2 c^2 d\tau^2 = m^2 c^2 dt^2 - m^2 dx^2 \) where I have now multiplied both sides of our equation by \( m^2 \) (after all, we seek \( E = mc^2 \), so \( m \), the mass of either your sister, or of Sis plus her rocket, has to be introduced somehow, doesn’t it?) From that,

\[
m^2 c^2 = m^2 c^2 \left(\frac{dt}{d\tau}\right)^2 - m^2 \left(\frac{dx}{d\tau}\right)^2 \quad \text{or} \quad m^2 c^2 = (mc\gamma)^2 - m^2 u^2
\]

Notice that it is the velocity \( u \) that appears in this equation. Now re-write this in this form:

\[
m^2 c^2 = \left[ mc \left(1 + \frac{1}{2} \frac{v^2}{c^2} + \cdots\right)\right]^2 - m^2 u^2
\]

\[
m^2 c^2 = \left[1 \left(mc^2 + \frac{1}{2} mv^2 + \cdots\right)\right]^2 - (mu)^2 \quad \text{or, if we, now, abandon Newton and we redefine momentum to be} \ p = mu \ \text{and energy to be} \ E = mc^2 + \frac{1}{2} mv^2 + \cdots \ \text{then} \ E^2 = (cp)^2 + (mc^2)^2
\]

If redheart is not moving at all, her momentum \( p \) is zero, and we have, at last: \( E = mc^2 \)