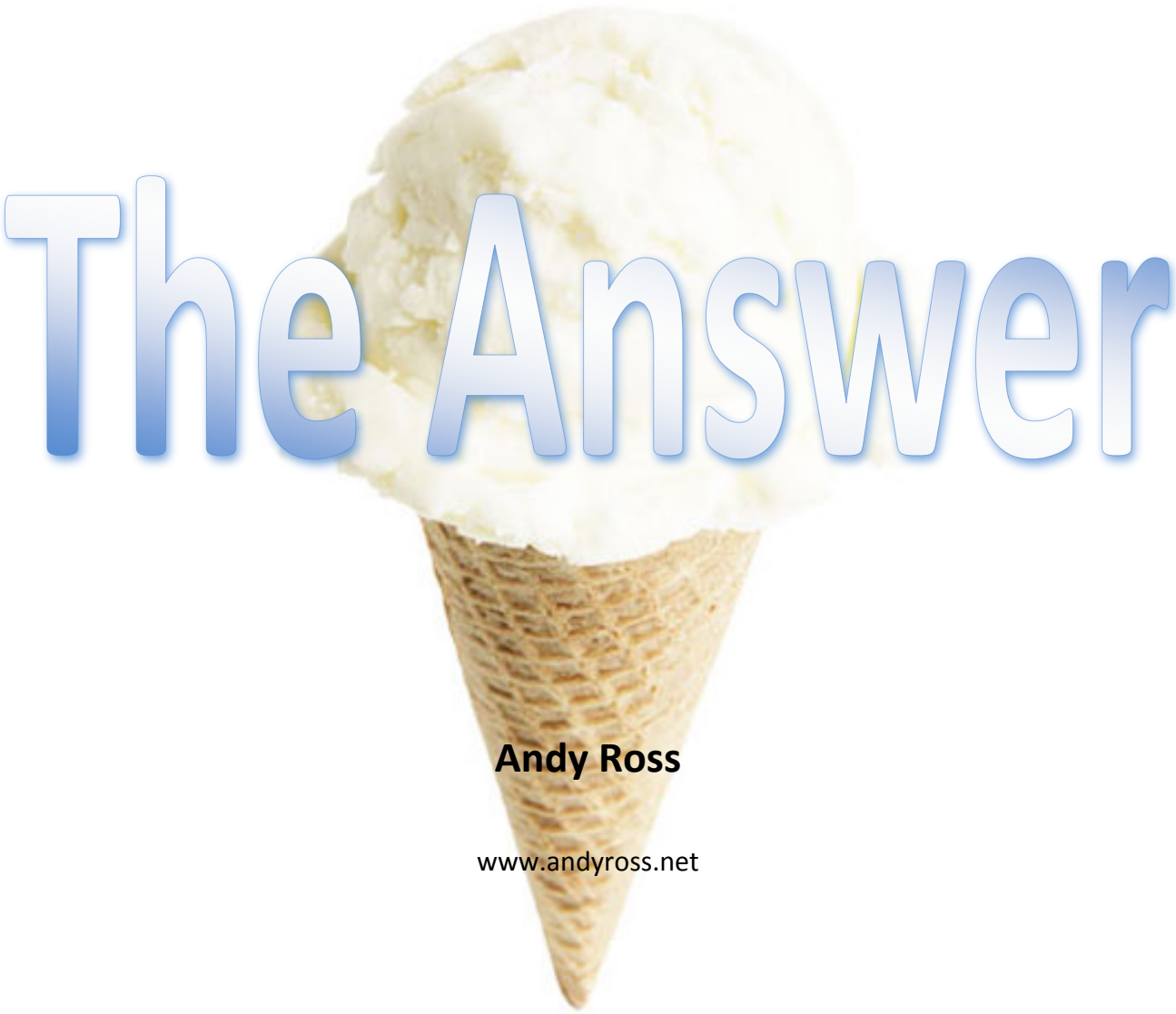

Andy Ross

www.andyross.net

THE ANSWER to the meaning of life, the universe, and everything is 42, said Douglas Adams in *The Hitchhiker's Guide to the Galaxy*. In the second novel of that trilogy, the hero Arthur Dent tried to discover the question to which 42 was the Answer. When someone playing Scrabble spelled out "forty two" Arthur pulled more letters from the bag, but only made the string: "What do you get if you multiply six by nine?" He despaired: "Six by nine. Forty two." When told on a BBC forum in 2007 that in base 13 arithmetic six by nine is 42, Adams responded, "I may be a sorry case, but I don't write jokes in base 13." As it happens, 42 equals 101010 in binary code, but this is still a joke.

The history of human attempts to find big answers is fascinating, to me at least, and seems well worth a longer look. More to the point, I have a big answer of my own, which is about as practical as 42 and rather less amusing, but at least more helpful in one interesting way. My answer emerges from logic and physics, and helps show how science shapes our view of the world. My answer also sheds light on a series of otherwise murky issues in the history of gods and basic dogma in our history, which emboldens me to present it here for public debate.

Any effort like this faces a formidable landscape of obstacles, and I have had to thrash around a bit. My aim throughout was to help us

all to be more incisive in our answers to various big questions by building on the state of the art in logic and physics, where basic new insights enable us to throw out a lot of old trash that has accumulated over the centuries. The new insights gain traction in the neurosciences, where their outcome comprehensively trumps many previous ideas in psychology and philosophy. The overall result is a core idea that invites a radical rethink of just about everything. We can reboot our operating software as a species from this core and learn to think beyond our previous limits. This is a lot to promise, I know, but it seems to work for me and I want to pass it on.

My credentials for this presumption are humiliatingly modest, I freely admit, but someone has to get the ball rolling. To try to reassure any readers who need more faith in my competence for the task ahead, I shall now relate my own little myth of the great discovery. In my teenage years in England I was good at mathematics and physics, and I won an award to study physics at Oxford. There, in the hubris following the Apollo landings on the Moon, I decided that physics was a great prelude to a deeper study of philosophy and dived in. Another award took me to London and yet another back to Oxford, and my appreciation of the hardest questions of philosophy grew. In the summers of 1975 and 1977, prompted by highly technical work in set theory and the foundations of mathematics, I drafted two dense volumes of logic in a massive effort to recreate a Hegelian philosophy of everything. (Hegel, you may recall, worked in the glory years of German philosophy between Kant and Marx on a dialectical theory of logic and history.) Those volumes encrypted the key insight for all my reflections in the decades since then.

The celebration had to wait. No one seemed to understand my idea. I joined the British civil service. When its walls began to close in, I went to work in the private sector as a teacher of mathematics and physics in London. But more advanced science was beckoning. In 1987, I got a job as a physics editor with the science publisher Springer in the university town of Heidelberg in Germany. Soon I moved to the computer science department, where I stayed for a decade and wrote a big science fiction novel along the way. Then I went off to work with the global software company SAP at its headquarters in Walldorf, a few minutes south of Heidelberg. Here was the information technology revolution playing out in thrilling live action. I joined an engine development team and wrote a book on its fast analytic engine.

Meanwhile, thanks to my SF novel, developments in the brain sciences had caught my attention. I went to numerous conferences on the emerging science of consciousness and published papers in the Journal of Consciousness Studies. Together with a few further papers, these formed the stuff of my book *Mindworlds*. In 2009, I retired from SAP and wrote a few more books, which reawakened memories of the quest. I returned to the UK to complete my mission.

The insight that I hope redeems my half-century of effort is now distilled to a simple idea of tolerable clarity. I propose to sketch it here and now. Then, in planned future work, I shall try to show how it helps us understand the history of the last few thousand years. Finally, in that future work, I shall review the big idea to see how far we have come with it and what more we can do with it.

Unity

Each of us starts our inner life with a bundle of sense impressions brought to a fuzzy and evolving unity. This ongoing unity woven from a changing bundle of stuff is key to our identity, and persists, with changes, for as long as we live. The philosopher who first saw this synthetic unity clearly was Immanuel Kant, who did so two and a half centuries ago in Prussia. His work inspired a generation of philosophers

in Germany, who between them made the biggest splash in philosophy since the ancient Greeks. A major figure for a while was Georg Wilhelm Friedrich Hegel, whose dialectical idealism made waves in the humanities for generations. But Hegel struggled with logic and ended up in a mess. Decades after his death, the mathematician Gottlob Frege cleared up the mess by making a fresh start. A century later, the result was the digital revolution that has transformed our world.

Meanwhile, the waves made by Hegel soaked Karl Marx, who turned dialectical idealism into dialectical materialism, founded the political movement of communism, and drowned in the Hegelian logical mess. It took a century of turmoil and many millions of wasted lives to live down the consequences. The result is the modern political landscape. Along the way, we have overtaken so many old ideas and beliefs from the past that many people who are still caught up in the fog of ages have lost the plot. Here we need clear thinking to sort out the key threads of our history.

The logic that Frege cleared up was only a start. Soon Bertrand Russell, then a fellow at Cambridge, complicated the picture and left a tangle of issues for mathematicians to grapple with. A young man called Kurt Gödel, who later spent many years with Einstein at Princeton, worked on them to make a logical breakthrough as shocking and dazzling in its own way as the breakthroughs that young physicists were making at the same time in quantum mechanics. Soon the world revealed by scientists looked strange and rather frightening. People were puzzled, and many retreated into old certainties that were no longer viable. Now, as the digital revolution sweeps all before it, billions of our fellows on this planet live in mental worlds that bear no coherent relation to the world of modern science. This is dangerous.

My insight builds on the synthetic unity that Kant identified and relates it to modern logic and physics. The result is a perspective that works in the brain sciences and puts a whole new spin on some old religious ideas that still have the power to cause chaos in our world. The task of sorting out those ideas and putting a better formulation of the truth on the table for all of us to work on seems urgent to me. But my first efforts stayed within science.

Logically, the brain is a neural network that uses associative logic to bring sense impressions and memories and so on to a synthetic unity that persists and evolves for as long as the owner of the brain is alive and alert. My idea was to represent this mortal coil, as Shakespeare called it, in logic and set theory. This needs explaining.

What Frege did wrong, and what Russell pulled him up on, was to say that anything and everything could be formalized in a single fixed and consistent system. Russell discovered a contradiction in the system, an expression of a paradox that emerges in any attempt to formalize a fixed theory of everything. Russell and his Cambridge colleague Alfred North Whitehead responded by writing a big trilogy, *Principia Mathematica*, in the years before the first world war, which obfuscated the logic Frege had pioneered behind a formidable thicket of logical weaponry. It was this trilogy that inspired Gödel to prove his astonishing result. As Douglas Hofstadter later put it, Gödel's theorem torpedoed the mighty flagship that Russell and Whitehead had launched upon the academic seas. The foundation of mathematics, also known as set theory, was revealed to sit in a soft logical basin where paradox always loomed.

To wrap up that story before embarking on my idea, Alan Turing picked up where Gödel left off. Gödel had invented an elaborate code to represent the formal theory of mathematics inside mathematics. His code revealed a world of recursive possibilities that has inspired writers of computer software ever since. Turing transposed Gödel's theorem to the

world of ideal computing machines, now called Turing machines. All modern computers are Turing machines in his sense. His limiting result is that no such machine can provably succeed in running any software one might care to feed into it. As a matter of logic, for some programs, unpredictably, it will go into endless loops, or crash.

Logically, a brain is a kind of computer. It too will sometimes crash, or go into endless loops that get its owner nowhere. My insight is to see that this limiting result applies to the Kantian software that generates a synthetic unity, to the Hegelian software that generates dialectics, and to the religious software that apparently reveals divine messages. More excitingly, it applies to the ultimate worldview of hard science itself, where in fact the scientific method can accommodate it harmlessly. Our task is to understand how all this comes about and to trace its effect in history.

Sets

At risk of terrifying readers whose math is shaky, I want to outline my 42 fully enough to enlighten bolder thinkers. Logic, as we all agree, is the science of valid inference, which is the skill of reliably deducing truths from truths and consistently avoiding false conclusions. Shortly before Frege went to work, the English mathematician George Boole formalized this sort of logic for what are often called propositions, which are statements that can reasonably be said to be true or false. The resulting Boolean algebra is a formal foundation for all the computer software that runs our world. Boole represented the truth values as 0 and 1. In this formalism, 0 represents false and 1 represents true. So the logic of propositions is reduced to the Boolean algebra of 0 and 1. This is where the digital revolution started.

But mathematics is fancier than that. One definition of mathematics is as the science of infinity. This may sound rather mystical, but it merely says that mathematics is the science of mastering and managing formal languages representing abstract concepts so as to say as much as possible, into infinity, without the manipulations themselves dissolving into infinity. The problem with propositions is that they are finite. And the glory of numbers is that they are infinite. Two worlds collide.

Frege found a way forward by discerning inner structure in propositions. He said that a proposition expresses the application of a concept to one or more objects. The proposition “Socrates is a man” says the concept of being a man applies to the object called Socrates. And the proposition “All men are mortal” says the concept of mortality applies to the potentially infinite set of men. Frege defined a system that lets one conclude: “Therefore Socrates is mortal.” His system worked across mathematics and reduced it to logic. (Actually, we now say he reduced it to set theory, and insist that set theory goes beyond pure logic in making existence claims for sets.)

Seen abstractly, concepts and objects are the two sides of sets. A set is an object, namely the object containing the objects that fall under the concept defining the set. The set puts its members under its defining concept. Alternatively, concepts classify objects into classes, and those classes are themselves objects called sets. Frege said numbers are sets of sets: The number *n* is the set defined by the concept of having *n* members. The number 1 is the set of all singletons, the number 2 is the set of all pairs, and so on. And off Frege went, defining all of classical mathematics in set theory, in two big volumes of dense formal derivations that represented his life’s work.

Alas, Bertrand Russell spotted the flaw just as volume 2 was going to press. What about the set of all sets that are not members of themselves? Is is a valid set or not? Horror! Paradox! Frege was driven to consternation and despair. Russell was moved to devote the next decade with his colleague Whitehead to cleaning up the mess. They created a forbidding theory of

ramified types to generate a hierarchy of sets ranked in a class system that throttled the paradox at birth. Gödel thought it was a step back from Fregean clarity and torpedoed it.

Sorry, but we need all this to see my 42. Other mathematicians built tidier set theories on axiomatic foundations and eventually settled on a theory of "pure" sets in which everything is balanced perilously on the empty set. The empty or null set 0 is the set with nothing in it. Now, following John von Neumann (who worked with Gödel and Einstein at Princeton and defined the von Neumann architecture for computers), we usually say the number 0 is the empty set, the number 1 is the set whose only member is 0, the number 2 is the set whose only members are 0 and 1, and so on. These numbers form the backbone of a universe V of sets. The universe is ranked by the numbers.

This "pure" universe is the defining image for my 42, so it pays us to examine it more closely. Each rank of sets is the set of all subsets of all sets in previous ranks. So the rank 0 version of the universe V is empty and identical to the empty set, the rank 1 version of V is the set whose only member is the empty set, the rank 2 version is the set whose two members are the empty set and its singleton, the rank 3 version contains those two sets and the pair set they make, and so on. The rank of a set is the lowest ranked version of V that contains it. The ranks form a cumulative hierarchy where each version of V accumulates everything so far. The magic comes when we use the Fregean innovation of a logic for "all" to include infinite sets and pile up more sets on top of them. We get a transfinite hierarchy, towering up into a paradise of sets so huge we have no stable notation to write out their definitions. All this is balanced on a point resting on nothing at all, a huge cone of snowy abstractions foaming up into infinity. Mathematicians call it the ice cream cone universe.

The cumulative hierarchy is the sacred totem of mathematics. Depending on some highly technical details that no one fully understands, just about all of mathematics can be represented in this structure, and hence given what counts as a foundation in logic. Formal languages of dizzying complexity form the scaffolding for the high priests of this fetish to construct the higher levels of the hierarchy, until all efforts fail in the shining glory of the transfinite paradise beyond the top ranks. This is the mathematical godhead.

My contribution to the worship of this totem was to spot a flaw that no one wanted to see. Everyone agrees that there is no consistent theory of the whole lot at once, and a consistent theory of an initial segment of the cumulative hierarchy cannot see beyond its topmost definition of V, by definition. In other words, any consistent theory is satisfied in a model consisting of a definite initial segment of the hierarchy, with a definite rank. So no consistent theory can exclude the possibility that above its model is nothing at all, emptiness, the null set 0. We get a loop, a coil, a twisting snowscape that vanishes in a puff of frost.

Obviously this horror must be banished forthwith, but we can only do so essentially by fiat. Life goes on, and sets continue to exist, as far as the "I" can see. The mathematical subject, about whom philosophers have said some strange things, cannot simply write off the investment of ages. Mathematical objects exist, into infinity. The great ice cream cone exists, and will continue to exist eternally, or at least for as long as mathematicians keep the faith. We are committed to doubling and redoubling our intellectual investment, exponentially, in the consistency of mathematics.

The universe V is our logical scaffold for everything. Think of the sets in V as populating a possibility space. Any and all possible constructs in any and all theories of life, the universe, and everything can be coded into this structure. The details are obviously contentious, and will keep experts busy for generations, but in principle we can say that V is our

flag in logic. Defend it we must, for beyond lies the madness of total logical chaos.

Any consistent logical theory, such as those defined in the Boolean algebra that computer scientists use daily, has models in V, and moreover minimal models of definite rank in V. The logic we use in daily life always tops out in some level of V. Logic works within a level. But between the levels there is scope for contradictions. This was a corollary of my discovery, and the portal to a new world where Hegel's notorious contradictions could be defused and given a sober analysis. Essentially, a discovery of any sort takes us up through the levels of V, and our progress is measured in contradictions overcome along the way. This is dialectics, also known as the launch pad for creation, evolution, new worlds of thought, and unfortunately, alongside these, an endless convoy of historical abuses and misuses of reason.

To see how my idea can work to defuse contradictions, consider any informative statement, such as: "Birds evolved from dinosaurs." To be informative, a statement must express an epistemic advance. It must carry us forward from an initial state of ignorance about the matter in hand to a final state of knowledge about that matter. In our initial state, a model that formalizes what we know can draw a blank on the evolutionary ancestry of birds. But in our final state, a minimal model to formalize our knowledge must include some configuration of objects and concepts such that birds in the model evolved from dinosaurs in the model. We have taken a small step forward from ignorance to knowledge, and henceforth any model of our state of mind must include at least that much more information than before. Any previous error in our worldview, such as the idea that birds were designed by a divine architect, is contradicted by our new knowledge. Thus, in principle, the florid contradictions that drove logical readers of Hegel's works to despair can be analyzed cleanly to generate statements that make some sort of sense. In short, informative statements have epistemological depth. They carry us upward from level to level in V. Logic itself is epistemologically flat. It works within levels.

That was some heavy stuff, I know, and it cost me the best years of my life of mind to get that much clear, but the payoff in terms of amazing insights was enormous, as I hope my future work will show.

Minds

All you need is sets (pause for a riff of Beatles music). The philosopher who for me is indelibly associated with that idea is Willard Van Orman Quine, who taught math at Harvard and took Russell's logical ideas further. His immortal idea (for me) is that, as a matter of logic, any ontology anywhere can be reduced to sets. Since then, software engineers have familiarized us (or at least some of us) with the idea of an ontology, or a set of things that can serve as a foundation for a realm of discourse. Having seen how Frege and Russell reduced the rich ontology of mathematics to sets, Quine was sure it would be easy enough to reduce anything else to sets, and sketched a few ideas to suggest how this might be done. If his certainty is justified, then human minds are reducible to sets too.

Our minds conform to logic, but they often defy flat logic and find inspiration in contradiction. When we come up with a new idea, an initial blank becomes something more than a blank, and this creation corresponds in logic to a change in the universe of sets, and more specifically to a move upward in rank in the cumulative hierarchy V. At any given moment, a human mind can in principle, though obviously not in accomplished fact, be mapped to a definite set with a definite rank in V. Let such a set be called a mindset. A mindset is a ranked version of V corresponding under some mapping to the state of mind of someone somewhere. That mindset is the logical shadow of the synthetic unity that Kant introduced in his

critique of pure reason. Logically speaking, our minds bring a mass of stuff represented by lots of odd sets to a unity represented by a mindset. And since we grow mentally from moment to moment, and sometimes shrink mentally (by forgetting or somehow losing our mind), our mindset changes, or rather we embody different mindsets from moment to moment. If we grow in mental stature, we occupy a rising succession of mindsets that can be mapped (by an ideal logician whom no one has ever met) to a rising series of ranked versions of V, in what we might reasonably call a dialectic.

This story of mindsets is a modern form of what little I understood of Hegel's dialectical idealism. Shorn of bombast, fudge, and nonsense, Hegel's logical ideas were frankly unimpressive, but this story is the plot line that for me redeems it all. If my soaring rhetoric of V-sets works as advertised, the core of sense in dialectical idealism does much more than rescue a man from a mess. It provides us with a core mechanism for adding temporal, evolutionary, and even spiritual depth to a discipline that would otherwise collapse into the manipulation of bits in computers.

Most people are aware of Hegelian logic at most through the idea of dialectical triads. A thesis calls forth an antithesis, and the contradiction between them is resolved in a synthesis. Well, my version of the triad is that an initial statement from a mindset coded as version 1 of the universe V is contradicted by a statement from a mindset coded as version 2, and their clash is resolved in a mindset coded as version 3, where version 3 has higher rank in V than versions 1 or 2. This is obviously pretty schematic, but the triad story was schematic anyway. In real life, you have to go through a lot of struggle to resolve a historical contradiction such as that between communism and capitalism, and the idea that you can represent all that in a neat little triad is fantasy. Talk of ranks in V cannot cut through all that either. At best it can suggest the potential logical complexity of the process by vaguely waving at the logical godhead.

Returning to minds, the idea that a human brain at any given time is in a definite logical state is already a big leap of faith. Classical logic, the logic of bits, naturally invites that assumption, but we all know we live in a quantum world where such classical clarity is not a given. What is given is a world where patches of clarity may be separated and undercut by uncertainty. In logic, uncertainty corresponds to propositions that defy categorization as true or false. For example, a natural way to evaluate the sentence "This sentence is false" is to map it neither to true nor to false but instead to some uncertain state that can only collapse to true or false after its uncharted semantic entanglements have been properly disentangled. Similarly, my mental state can include true bits, false bits, and queasy bits that are still too entangled to call. So the idea of mapping all that to a definite set seems way too optimistic.

This is not the place to dive into quantum physics, but it is the place to point toward it. Sure, a mind is in large part a fuzzy thing, which runs on a platform more correctly described by quantum theory than by classical theory and for which therefore complete classical clarity is unattainable. Something similar holds in pure mathematics, where Gödel drove a logical torpedo between completeness and consistency. For minds, we can only plant a few danger flags for now and promise to return when much more background is in place. In short, we shall find that a mind is a process, not a thing, and better described by a dialectic than by a single set. A mind is not a closed set but an open process.

History

The history of human life on Earth is too complex for any of us to see clearly, and far too complex to reduce to a set. But it makes sense to try to map it to a series of sets in an attempt

to find patterns and trends that aid understanding. In short, we can trace a dialectic there and use it to map our progress as a species toward the godhead. When Hegel did that, he traced progress toward the "absolute" in which the Prussian militarist state was the summit and pinnacle of world history. We all know what came of that idea in the twentieth century. But we do well to trace the flow in our modern terms and see what deeper understanding of the whole horror show we can reach. It turns out, in my analysis, that the entire juggernaut of monotheism invites a clear logical reading in terms of the V-set story, and that the march of the juggernaut is ongoing in our historical epoch. My reading invites abstraction of the core logic to leave the story bloodless, hence both useless as religion and harmless in science, where we can go to work to unpick it all and move forward with new ideas that go much deeper into the fabric of reality.

To cut to the chase, my analysis will reveal that the historical godhead shoots off to cosmic infinity and leaves us with a drive toward first planetary, then galactic, then cosmic dominion, all destined in every incarnation to vanish in a puff of frost at the drop of a mindset. Mortal agents like us drive coils within coils, ever onward, pushing out the envelope of reality, until our personal coils loop and crash, to dump us in the muck of ages. Yet over time, the efforts add up, until at some time in the deep future our evolutionary descendants will surely do more than we ever dreamed. By definition, we cannot wish for more.

Andy Ross

www.andyross.net