

The Exponential Explosion

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How is it that the most intelligent and creative species on this planet has also become the most dangerous?

On the one hand, we are truly wondrous beings, with extraordinary potential. We have studied the world around us, and been awed by what we've discovered. We are aware of our history, of how we came to be here. We can look ahead, imagine a better future, make choices, and reshape the world to fit our needs. We have liberated our bodies from much physical toil, freed ourselves from the suffering of many diseases so we can live longer, more active lives, and relieved ourselves from many other burdens. We are capable of love, deep compassion, an appreciation of beauty, and the creation of great art, music, and poetry. We find meaning in our lives and have a sense of justice. Nothing like us has ever walked this Earth.

Yet, despite our intelligence, creativity and technological prowess, we are destroying our planetary support system at an alarming rate. The forests we once inhabited are dying, to be replaced by concrete, wasteland, and desert. Species are becoming extinct as fast as in any of the great planetary cataclysms of the past. The air is hazed with pollution. Topsoil is blowing in the wind. Rivers run sour into the sea. The oceans are increasingly acidic. And the belly of the Earth has been ripped open in the unending quest for raw materials and energy. In the worst case, the planet will be so changed by our actions that human beings themselves will not be able to survive. In a hundred years we may have become extinct—or be well on our way to extinction.

This is the tragedy that has befallen us. A species with such unprecedented capacities may be about to blow it.

Where Did We Go Wrong?

Many have tried to identify when we fell from grace. Some see it in the European Enlightenment when human activities took precedence over nature. Others trace it back to the Industrial Revolution, which triggered a burgeoning consumption of natural resources, with its consequent pollution. Some put the blame on the oppression of indigenous cultures by colonialism. Or the legalization of usury and the charging of interest, leading to economies wedded to continual growth. Some see it in the movement away from the land to living in cities. Others in the patriarchal takeover of human culture. Or the loss of our indigenous myths and initiation rites. Others trace it back to the Agricultural Revolution, when we moved from a hunter-gatherer lifestyle, based on coexistence with nature, to one in which the world was ours to control and exploit. While some argue that the root of the problem goes back even further, to hunting itself.

All of these undoubtedly played a role in our present-day woes. But I do not believe there was anywhere we went wrong. There is no one to blame; no group that was at fault. The root of our current predicament goes much deeper than any particular human activity or era. It lies, somewhat paradoxically, in the one factor that has given us such an advantage over other species—our enhanced innovation, and the accelerated pace of development that followed.

The Most Innovative of Species

Three factors gave early humans an innovative edge. Their larger brains brought greater intelligence; the dexterity of the human hand led to better tools; and the advent of speech allowed them to share their discoveries. Combine these three trends and you have an intelligent creature able to amass a growing understanding of the world, to think, reason and make choices, and thence mold the clay of Mother Earth into a diversity of new forms. An entirely new form of innovation had appeared.

By a million years ago they had tamed fire. A hundred thousand years ago they were wearing clothes, making jewelry, and burying their dead. Twenty thousand years ago they'd developed farming. Five thousand years ago civilization had begun.

With it came writing. Limited to speech alone, ideas could not travel far without distortion or loss. Writing enabled the creation of a more permanent record, handing down ideas and discoveries to future generations.

Six hundred years ago the printing press began to have a profound impact on the distribution of knowledge, paving the way for the Renaissance, with significant advances in art, science, and philosophy, along with an expansion of trade across the world.

With the European Enlightenment of the seventeenth century, the power of reason gained dominance, leading to the birth of the scientific approach and the quest for reliable truth. The Earth was no longer flat; nor was it the center of the Universe.

A century later, the Industrial Revolution was born. We today may bemoan some of the repercussions of industrialization, but its founders were a group of visionaries who saw the potential of the steam engine to relieve the load on human muscles. Nobody back then knew about atmospheric science, or that these new technologies, as they came to serve a population exploding much faster than anyone imagined and with unprecedented material appetites, would come to threaten the very survival of humanity.

Information technologies were developing, too. The telegraph made it possible to send messages instantly across the land; the telephone enabled one to speak with someone far away; radio allowed one person to talk to many others; television brought the ability to see others and events across the world. The Internet revolutionized the distribution of information. Twenty years ago few foresaw that we'd be shopping online, streaming movies, engaging in social media, or any of the other host of online activities that today we take for granted.

Homo sapiens had become a technologically-empowered intelligence, creating more effective and efficient tools with which to modify and control the world, and using them to get more detailed knowledge and better understanding of the world—which in turn led to improved technologies, and even better knowledge. Innovation bred further innovation, adding fuel to what had become an evolutionary explosion.

Reframing the Future

Five hundred years ago, there was little concept of progress. Time was measured cyclically—the cycles of days and nights, the moon, the seasons, the years, a lifetime. One generation lived and worked much as the previous generation. There may have been occasional innovations—better food preservation, sturdier buildings, new hunting skills—but generally the cycles repeated year after year, with little change.

With the advent of the Renaissance, the European Enlightenment, and the Industrial Revolution, change came faster. People could remember the days of their childhood, before the steam engine, electricity, or automobiles. Progress was now an intrinsic part of life. We looked back to how things were, and forward to how things would be. Cyclical time had given way to linear time.

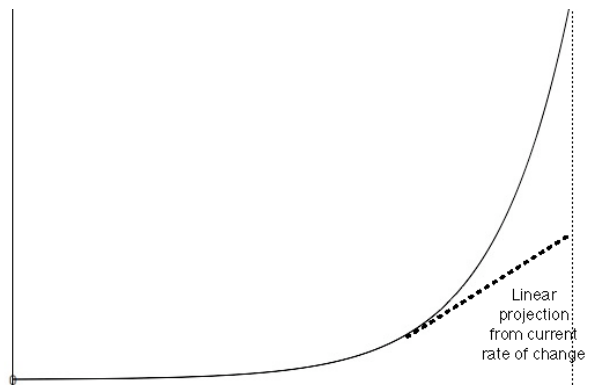
Today, technological breakthroughs spread through society in years rather than centuries. Calculations that would have taken decades are made in minutes. Communication that used to take months happens in seconds. Development in every area is happening ever more rapidly. We look back now, not only to how things have changed, but also to how much faster things are changing. We've entered the era of exponential time.

The Fallacy of Linear Thinking

Our minds, however, find it difficult to think in exponential terms; humans evolved in a world where the pace of change, if any, was much slower. As a result, we often don't see the full implications of exponential change and where it is leading.

You may have heard the story of the king who was asked for one grain of rice on the first square of a chessboard, two grains on the second, four on the third, doubling each time till the 64th square would have... how many grains? A mindboggling 18,446,744,073,709,551,615. That's approximately 45 trillion tons of rice, or a heap as high as Mount Everest—far more than most people intuitively expect.

In a similar way, we fail to see where exponential rates of change will take us. When we contemplate the future 50 years from now we usually extrapolate the current rate of progress into the future. If this much change has happened in the last 50 years, then we imagine a similar amount in the next 50 years. In reality, it may take only 20 years or so to witness a similar amount of progress.



When we imagine our species hundreds or thousands of years in the future, we unconsciously assume that progress will be happening at a fairly steady rate—and in most cases much slower than today. Take the *Star Trek* scenario, for instance, set a couple of centuries from now. Technology on the starship *USS Enterprise*, and back at Federation headquarters on Earth, remains basically the same over a hundred years. New versions of the *Enterprise* are built, with new capabilities, but the underlying technology hasn't changed much.

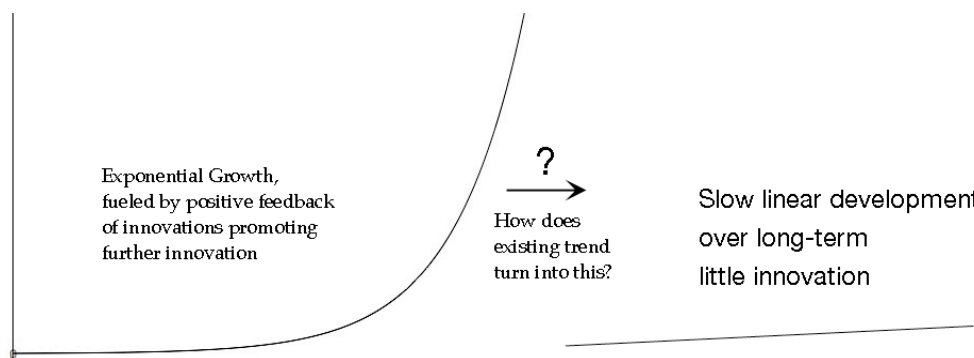
But how could that be? Would the rate of innovation have slowed way down? There is every reason to suppose that science and technology would still be progressing rapidly. Indeed, given exponential rates of change, the pace would have become unimaginably rapid long before the *Enterprise* was launched—and even more rapid in the years thereafter.

The same is true with almost every other long-term vision of humanity's future. They are not set within a context of accelerating change. By the middle of this century, the rate of progress will be far faster than today's dizzying pace. By the end of the century it would be many times faster still. In the century beyond, the curve would be off the charts. Like the growing mountain of grains of rice on the king's chessboard, it would be way beyond our comprehension.

Our Blind Spot on the Future

Our inability to appreciate the full implications of exponential time has led to a major blind spot on the future. On the one hand, there is every reason to believe rates of progress will continue speeding up, taking us ever-more rapidly into futures that are as far beyond the world we know today as this world is beyond the stone age.

On other hand, when imagine the world hundreds of years from now, or even thousands or millions of years from now, we still think in terms of linear time with its relatively slow rate of progress. We ignore the implications of exponential growth and unconsciously assume that a trend that has been going on since the dawn of time won't continue. That somehow exponential development turns into a slow linear development?



No Avoiding Acceleration

It is true that no exponential growth can continue forever; eventually it will reach limits that slow it down. And it may well be that population, energy consumption, urban expansion, or some other facets of this acceleration, reach their respective limits. But the pattern we are considering here is

not exponential growth in one particular area. It is the overarching pattern of ever-increasing rates of change. It is this that is set to continue, not any particular form of it.

Perhaps future technologies will allow more efficient, more elegant and more sustainable ways to satisfy our needs. Maybe advanced artificial intelligence will be able to solve many of our problems, mitigating the effects of climate change, inventing ways to clean up pollution, and creating economic systems that distribute wealth and resources more equitably. Or, as some hope, there may be a widespread shift in human consciousness bringing different values and priorities.

But even if such shifts were to come about, innovation would not come to an end. We might choose to apply our creative capacities in more sustainable ways, but innovation would still breed further innovation. The rate of change would not stop gaining speed; it would merely move on into other areas. Humankind will find itself on a new, and even steeper, curve, one that may be as far beyond our imagination today as the Internet would have been to Galileo.

There may be some upper limit to the rate of change—limits as to how fast the various human, social, and planetary systems could adapt. But such limits would not mean that the rate of innovation slowed down; only that it would no longer be gaining even more speed. We would still be living in a world where change came many times faster than today. Hardly a sustainable, or even desirable, world. And certainly not the more sedate long-term future we dreamt of.

In short, there is no avoiding this accelerating trend. We'd have ended up in similar situation of spiraling rates of growth whatever our path. We may be responsible for some of the forms it has taken, but not for the acceleration itself. Exponential rates of development are intrinsic to evolution itself—the inevitable consequence of the positive feedback loop of innovation building on innovation. There's no reason to suppose it will now slow down. Explosions don't suddenly stop and revert to a slow burn.

It therefore behooves us to explore how the future looks on the premise of exponential time.

Where Are We Headed?

When we look at where humankind may be headed, it is easy to focus on the many exciting new advances on the horizon: quantum computing, artificial intelligence, nano-tech medicine, reversed aging, 3D-printed organs, self-repairing machines, human-cybernetic interfaces, brain enhancement. All these, and more, will likely come about in some form or other. In addition, there will be developments that we today cannot imagine.

Given the unprecedented opportunities in such burgeoning development, it is easy to see the future in rosy terms. However, along with the many opportunities and benefits these advances may bestow come some valid worries. Elon Musk, the late Stephen Hawking, and others have expressed serious concerns about automated weapons and "killer robots" running awry, falling into the hands of extremists, or being used by dictators to subdue populations. Others have raised alarms about genetically modified viruses escaping from laboratories, or being deliberately released by terrorists, or psychopaths. Or ravenous, self-replicating, nano-robots finding their way into the wild, outstripping natural competitors and turning life to dust—the so-called "gray-goo" scenario. These technologies are all hurtling forward, propelled by market forces, without due consideration of their potential perils, leading some to call for a deliberate relinquishment of further research in various fields.

In addition, to dangers such as these, there is another, more general, downside to ever-increasing rates of change that is often overlooked—namely the stress the acceleration places on all the systems involved.

The Stress of Acceleration

Stress may generally be defined as a failure to adapt to change. In human terms, the more we have to attend to, plan for, worry about, and take care of—i.e. the more we have to adapt—the more likely we are to suffer stress, with its various undesirable consequences in terms of physical, mental, and emotional health, and repercussions on family, friends, and colleagues.

Today the increasing pace of life is a growing source of stress. There are new technologies to learn, more information to keep abreast of, more time consumed by social media. Many find themselves having to work longer hours, even weekends. The amount of quality time we can have with ourselves, family, and friends, relaxing and recovering from the pressures of work, is getting less, and for some disappearing completely. As adapting to increasing change becomes more challenging, exhaustion and burnout become increasingly common.

It is not only people who are experiencing the stress of ever-faster change. Our social, economic, and environment systems are all impacted as they fail to adapt. And with potentially disastrous consequences.

The exponential-like growth of the human population is now, thankfully, beginning to tail off. Nevertheless the consequences for food, water, housing, geo-politics, and other issues are still dangerous, and growing. This is compounded by the growing numbers of people seeking the lifestyle of the more developed countries, increasing the demands on already scarce resources.

Oil reserves are running out because we are consuming them a million times faster than they were laid down. Many other resources, such as platinum, copper, zinc, nickel, and phosphorus, all of

which are crucial for contemporary technology, will have run out, or be in short supply, within a few decades. Yet our demand for them continues to grow, exacerbated by the rapidly growing needs of emerging economies.

On the other side of the equation, rapid growth in industrialization has led to an accelerating profusion of pollutants in the air, soil and sea. Some are now being released thousands, or in some cases millions, of times faster than the planet can break them down.

Most significantly, the increasing accumulation of carbon dioxide into the atmosphere, stemming from the accelerating consumption of fossil fuels, has led to a climate crisis. Previously, plants and oceans reabsorbed the gas, but it is now being emitted many times faster than these systems can handle. The repercussions, we are now beginning to appreciate, will be devastating: more extreme weather, unprecedented heat waves and drought, widespread crop failures and famine, flooded coastal regions, and mass migrations, to name but a few.

To make matters worse, most of these ramifications of accelerating development are on their own accelerating curves. Species are becoming extinct faster; temperatures are rising faster; glaciers are melting faster; sea levels are rising faster; ocean plastic is accumulating faster.

Furthermore, these various accelerating trends are not happening in isolation. They're an interwoven set of crises, events in one area exacerbating the impact of others. As food, water and other resources become increasingly scarce, global conflicts are likely to increase. Unprecedented natural disasters could promote economic collapse, leading to social breakdown and increased authoritarianism. Epidemics of drug-resistant bacteria and zoonotic diseases, uncontrollable wild fires, biological and chemical terrorism, collapse of the Internet through hacking or cyber-war, increasing systemic chaos—all are possible. Doubtless some will happen. And, more than likely, completely unforeseen events will also take their toll.

A system can tolerate only so much stress before it breaks down. Spin a wheel faster and faster, and the increasing stress will eventually break it apart. In a similar way, as rates of change grow ever faster, the systems involved will reach a point where they too begin to crack. Whether it be our own biological system, social, economic, and political systems, or the planetary ecosystem, the stress of ever-increasing change will lead to increasing breakdown.

Crises will pile upon each other faster and faster, heading us into the perfect global storm.

A Most Uncomfortable Conclusion

We thus arrive at what is initially a most uncomfortable conclusion. When we consider the future from the perspective of exponential rather than linear time it appears that technological civilizations are intrinsically short-lived.

They are short-lived, not because of any fault in technology itself, or wrong-thinking on the part of the people, but from the acceleration itself. Innovation will keep breeding innovation, furthering not only exponential growth, but also exponentially increasing strain on the biological, social and planetary infrastructures. Eventually they can no longer hold, and the system breaks down.

Thus the acceleration does indeed finally come to an end—but to an end of its own making. It ends not because we change our ways, or get innovation under control. It comes to an end as we

spiral into the center of our temporal whirlpool—a time we started heading toward as soon as the evolutionary engine of innovation was put in our own hands.

Doom and Light

The future is not, however, all doom and gloom. The conclusion that human civilization is destined to end—and in the not-too-distant future—may, at first sight, seem to imply an end to the many scientific and technological advances on the horizon.

If we look through the lens of linear time, it might appear to need centuries, or millennia, for our species to achieve all we imagine possible. From this perspective, the continued advancement of our species demands we change our thinking and mend our ways. If we don't, things will fall apart and that vision of a hopeful future will expire. On the linear view it is a race between breakdown and breakthrough.

From the point of view of exponential time—which is the perspective we must now take seriously—the interval between significant advances will steadily decrease. We will see technological progress way beyond that which we can now imagine, plus equivalent advances in scientific understanding, all compressed into shorter and shorter periods.

Breakthrough and breakdown now become two sides of the same coin. They are ramping up together, and coming to a head together. No longer is it a question of “either-or,” but an acceptance of “both-and.” In the coming decades we will see technology beyond our dreams in a world that's breaking at the seams.

We started this exploration with the question of how is it that the most intelligent and creative species on this planet has also become the most dangerous? The answer is now becoming clear: the two go hand-in-hand.

What If There Were No Future?

Not surprisingly, most people have great difficulty accepting our species may not have a long future ahead. It's the last thing we want to hear. We knew human beings would not last forever, but most of us have imagined the eventual end to be way off in the distant future. We think this intelligent, creative, self-aware being ought to be around for the long-term. The realization that our collective end may arrive much sooner than expected can come as quite a shock.

Obvious parallels exist with our own death. We know it is coming, but unless we are diagnosed with some terminal illness or suffer a potentially mortal injury, we tend to push it away to some time in the future—not tomorrow or next week. On the other hand, accepting our own mortality is part of being a mature human being. Indeed, confronting death directly can produce profound shifts. People may reconsider what is important, value love more than wealth, seek to make amends for past misdeeds, find a renewed purpose in life, and live more for the present moment.

Here, however, we are facing the end, not of our personal lives, but also of our species. And this can be much harder to accept. When we look at all we have created, all the good there is in us, all that we hold dear, and all we might yet become, it is difficult to imagine this not continuing for a long while.

To make matters worse, what little future may lie ahead, does not look as rosy as we might have hoped. The increasing strain of exponential growth on various human, social, and ecological systems point to things coming to a head this century. Or rather, I should say “increasingly coming to a head,” since the consequences of this stress are already apparent in today's world. Hardly welcome news for younger generations today who, even now, view the future with growing despondency. Or for parents, as they picture their children and grandchildren growing up in worlds very different from those they'd hoped they would inherit.

Collective Grieving

As the reality of the unraveling hits home, there will be widespread despair, depression, and distress. What have we done? This is terrible, the future looks so bleak.

How will we deal with such pain and grief? Will we lose ourselves in panic and terror? Anguish over how our lives will unfold as we head into the eye of the storm? Will we go even deeper into denial, refusing to accept what is becoming increasingly obvious?

Many already feel a growing sadness at the dying coral reefs, the melting of the ice caps, the destruction of rain forests, and the loss of species never to return. This can only increase as the environmental impact becomes even more severe, and we begin to suffer the impact in our own lives and the institutions we so depend upon.

We've been conditioned to keep such feelings at bay. To grieve briefly perhaps, then wipe away the tears and carry on with life. But, as psychologists are wont to point out, keeping our sorrows at bay numbs our being and blocks our vitality.

Unexpressed grief is often sublimated into anger and blame. It is easy to get angry at the corporations, the politicians, the wealthy, the Church, the military, the terrorists, or anyone else we think is to blame for our predicament. They may be to blame for particular situations that have arisen, but ultimately there is no one to blame for the overall unraveling. It is the inevitable

exponential development, with all its consequences, that has brought us to this point. We'd have ended up in a similar situation whatever path we took.

Will we be able to move beyond fear, denial, anger and blame to allow in our grieving and through that move on to acceptance, facing an unknown future with courage and an open heart?

Will we be able to let go of our attachment to how things should be, our hope that things will turn out well in the end, and accept that this is the way it is for a technologically-empowered intelligence spinning ever-faster into the eye of its evolutionary hurricane?

Preparing for the Unpredictable

How then will things unfold? Perhaps the only certainty is uncertainty. The future will not only be unpredictable, it will become increasingly so. As developments are compressed into shorter and shorter intervals, the prediction horizon will move closer and closer, making it more challenging to make any long-term prediction.

Rather than trying to predict what might happen, and what particular eventualities we should prepare for, we should be focusing on preparing for a future in which the only certainty is uncertainty. For this we will need to become more resilient.

Resilience is defined as the ability to recover from setbacks. In this case, the ability to recover from unanticipated challenges and problems as the winds of change whip up into a storm of change, and then a hurricane of change.

Trees provide a good lesson. If a tree is to withstand a storm it must be flexible, able to bend with the winds. A rigid tree will soon blow down. In addition, it must have strong roots and be stably anchored in the ground.

The same is true for us. If we are to survive the coming storms—along with some unanticipated exceptional gusts—we need to be flexible. We've never been in this situation before, and have no past experience to go on. We'll need to let go of outdated thinking, habitual reactions, and assumptions as to how to respond, and find the inner freedom to see things with fresh eyes and draw more fully on our creativity.

Second, like the trees, we will need greater inner stability. We need to be stably anchored in the ground of our own being, so that when the unexpected suddenly arrives, we can remain relatively cool, calm and collected, not thrown into fear and panic. If we lose our inner equanimity and react emotionally to every new change, we will become increasingly stressed and more prone to burnout. In this respect, it will be more important than ever to find time to unwind from the ever-increasing busy-ness of our lives, time to put things in perspective and respond with a clear head.

A third factor that helps trees withstand a storm is being in a forest of trees. They soften the wind for each other. Similarly, we will need the support and companionship of others. The future is uncharted territory, and we will all feel vulnerable or shaken at times, needing to express our feelings or asking for emotional support. Caring for each other will become more valuable than ever, helping alleviate stress and suffering, adapting to unexpected circumstances, letting go of cherished lifestyles, and adjusting to new social and economic realities. We will need to open our hearts and be more forgiving, seeing ourselves with kinder, non-blaming, eyes.

For me, acceptance of the situation has brought with it some surprising shifts in attitude. I am not so angry at the people whose views and actions I disagree with. I am no longer so upset by the latest political shenanigans, economic swings, or social unrest. This is simply how it is to be living through the final generations of an intelligent, technological species. There is no blame to be apportioned. Instead I can be more understanding, more forgiving.

Nor does it mean I no longer care for the world around me. I still want to do what I can to preserve the planet. But now I want to do so for the planet's own sake. Perhaps the best we can do with our remaining years is to make sure we leave the Earth in as good a state as possible for the species that remain and those that may follow.

A Blossoming of Consciousness

It also leads me to a different story of our cosmic significance.

We don't know how common life is in the Universe. Maybe it arises on only one in thousand planets; or less. On how many of these do intelligent tool-using species emerge? Perhaps only a tiny fraction of those with life. But on those that do, something miraculous happens. A bud of creative intelligence suddenly appears.

Within a short time, cosmically speaking, it starts to bloom, bursting into an exotic, multifaceted cultural inflorescence. Billions of self-aware petals, seeking to become all they can be; to know all there is to know.

As innovation continues to breed innovation, knowledge takes off on its own accelerating curve. We have learned as much about the physical world in the last fifty years as we did in the previous five thousand. And we may learn as much again in the coming ten. Physics is approaching a "theory of everything," a set of mathematical equations that underlie all the forces of nature. We are not there yet, but many believe the breakthrough could happen any time. In cosmology we are beginning to understand how the Universe came into being, and where it might be headed. Again, we are not there yet, many unanswered questions remain, but discoveries in this field are coming fast. Similarly with life itself, progress in molecular biology is proceeding at such a rate that we may soon come to a full understanding of life.

However, knowledge of the physical universe is but half of what there is to know. We are not only aware of our experience, we are aware that we are aware. And no knowledge of the cosmos could ever be said to be complete if it did not include a full knowledge of awareness itself, the *sine qua non* of all knowing. Today the interest in consciousness itself is rapidly growing, both scientifically and on a personal level. Who knows where that might lead?

In the coming decades we may gain as much knowledge as we have over the whole of human history. Or perhaps even more. Within a short period of linear time we may come to a complete knowledge of the world, both around us and within us. This does not mean knowing everything it is possible to know, but everything this particular intelligence could know in this biological form, from this point in the universe.

Another bud of consciousness will have blossomed.

Exiting with grace

Here we are, wondrous beings, with unique gifts and abilities. We can learn about the world we live in, and the Universe around us. We have developed a wealth of technologies with which to improve the quality of our lives. We are capable of empathy and love, an appreciation of truth and beauty. We find meaning in our lives, and aspire to grow even more.

There is much to celebrate about us. The question is: Can we celebrate all that we are, and may yet become, while accepting that our species is here for but a brief flash of cosmic time?

I am reminded of the so-called century plant that flowers once in twenty or so years. When it does finally bloom, we marvel at the giant stalk, holding high a magnificent array of flower-laden branches. The spectacle is made all the more awesome by the knowledge that it flowers but once; then dies, its purpose complete. Can we celebrate ourselves in a similar light? Another

blossoming in the cosmos. An exquisitely beautiful flowering of consciousness. A miracle of creation.

Can we let go of the cherished belief that we are here to stay, rejoice in our existence, and live our final days with grace?

Despite knowing the journey, and where it leads, I embrace it. And welcome every moment of it.

~ Louise Banks in *Arrival*