Book Review

Stephen Hawking and Leonard Mlodinow: *The Grand Design*
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The Kingdom of Lies

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ABSTRACT

In their book, The Grand Design, Hawking and Mlodinow, faithful disciples of the scientific method, give an account of what they and their brethren in the physical sciences have discovered by following the evidence gleaned in systematic observation and measurement using the most advanced technologies available today. In their lifelong search as physicists, for the Holy Grail of a theory of everything — a Grand Design — the evidence it seems, has led them, not to a unified theory of everything, but to the heresy of all scientific heresies, a theory about theory making.

Key Words: Grand Design, Stephen Hawking, Leonard Mlodinow, scientific method, physical science, Holy Grail, theory of everything.

A Parable

In the beginning the king was told that all the crops in the kingdom would be affected by a terrible blight. Anyone who ate of them would go mad. He called in his trusted adviser and asked him what to do.

"Of course," the king said, "there is enough grain left from last year's harvest so that you and I could continue eating of it. We could remain sane and keep all the others from doing any harm."

"Your majesty," replied the wise man, "if only you and I are sane and all the rest are madmen, who is it that will be locked up in the asylum?"

"I understand," said the king, "but what is left for us to do?"

"The best we can do", replied the sage, "is for both of us to eat the same grain as everyone else but before we do I will place a mark on your forehead, and you will place one on mine, so that whenever we look at each other we will be reminded the we are also mad."

(As told to Arthur Green by Rabbi Nahman of Braqtslav)

In the human enterprise we accept that prediction is possible and it is by the device of our predictive stories — our theories — that we have prevailed as a species. In everyday experience our stories concern themselves with mundane matters of prediction: A red sky at night is a sailor's delight. The slowest cashier line in the market is always the one that I am in. The stock market went up today on news of lower housing prices. Vitamin supplements will

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make me live longer. So goes our predictive storytelling in every moment of wakeful awareness as well as in our fitful dreams.

In our never-ending quest for better prediction, we are driven to construct grander and grander stories that consolidate and reduce the number and complexity of the stories we must resort to in prediction. Given that prediction is the principal business of being human and that our survival depends on how well we do it, it is not surprising that throughout history, the human enterprise, in the grandest sense, has been to construct the ultimate story of all stories, the one true story that might confer upon us powers of perfect prediction — the story of The Grand Design.

Hawking and Mlodinow speak to the storytelling process on p. 51 of their book. A theory (an explanatory model) is more "good" to the extent that it demonstrates sensual "elegance", "is parsimonious in containing "few arbitrary or adjustable elements", is comprehensive in "explaining all observations", and "makes detailed predictions about the future" that can be tested in practical experience.

Over the ages many storytellers have laid claim to the discovery of the codex of the Grand Design — the theory that explains everything. The stars, the bones of chickens, the lay of tea leaves, or the words of gods and God miraculously revealed are but a few of the stories that have been turned to our predictive purposes, but most have fallen by the wayside, having failed one or more of the tests of "good" storytelling.

The Grand Design is a story about storytelling in which the evidence gleaned in systematic observation and measurement has led the disciples of science down a storied path of increasing elegance, parsimony, comprehensiveness, and verification in practice, to a story in which the final outcomes produced by their method of questioning may very well have brought them to a dead-end — full stop!

In the early going the authors explain that our superstitious and metaphysical mythic stories placed us at the center of the universe with all the world revolving around our being and intentions, but over time the predictive power of models that displaced us from the center and relegated us to the status of mere participants in a law-abiding world "out there" did better at meeting the tests of story goodness: "The revolutionary idea that we are but ordinary inhabitants of the universe, not special beings distinguished by existing at its center, was first championed by Aristachuc…" (p. 21).

This displacement theme, in which man's existence is subordinated to externally determined laws, forms the foundation for the world narratives of both classical science and modern institutionalized religion. In other words, this modern worldview asserts a narrative in which there is a discoverable true world "out there" that obeys the laws of nature or the laws of nature decreed by gods or God, and that by decoding these external laws, perfect prediction becomes in principle at least, possible.

In the popular press, much has been made of the idea that Hawking and Mlodinow are challenging religious thought, but the authors make it clear that this is not their aim. The authors say that they do not wish to concern themselves with the dividing line between religious stories and scientific stories, asserting that science cannot disprove the existence of God or gods. What scientific storytelling has managed to do, they say, is to tell a story in which the existence of the world we know does not "require: that there be a God or gods. A

story is a story, and it is not the truth of a story that gives it legs, but rather its elegance, parsimony, comprehensiveness, and predictive power."

The stories told in classical science, they explain, are a product of a method of story construction: "[M]ost scientist would say a law of nature is a rule that is based upon an observed regularity and provides predictions that go beyond the immediate situations upon which it is based" (p. 27). And furthermore, "[M]ost laws of nature exist as a part of a larger, interconnected system of laws" (p. 28).

Unlike mythic and religious stories, the stories told using the scientific method of story construction must reflect self-consistent stories within stories. The authors credit Laplace with setting the gold standard of scientific storytelling, "…given the state of the universe at one time, a *complete set of laws* fully determines both the future and the past" (p. 28).

In the scientific method of storytelling, the truth-value of the lawful stories constructed can be supported by an ever-increasing number of predictions confirmed in practice, such as the rising of the Sun in the East, but a single practical falsification of a scientific story is sufficient to render that story useless, such as the day on which the Sun rises in the West. According to the authors, the first shot across the bow of the ship of truth-seeking was fired by René Descartes, who asserted the relational understanding of the principle of *initial conditions*: "In order to apply the laws of physics, one must know how a system started off, or at least its state at some definite time. (One can also use the laws to follow a system backward in time.)" (p. 20)

The authors might have better stated this in the following manner: In order to apply the rules proposed *in any story*, one must assert how the system starts off, or at least its state at some definite point in time. Every story must have a beginning, whether its initial condition be a mote in God's eye or a Big Bang.

It can be argued that the initial state for the story of scientific storytelling being told in *The Grand Design* begins with Sir Isaac Newton, a practical and God-fearing man who told a story of an interlocking mechanical universe that predicted the motions of things observed on earth and in the heavens, and a darn good story it was. Given the ability at the time of humans to observe and measure such things, his predictions were both useful and, for all intents and purposes, spot on!

Given the efficacy of his story, Newton did not have to work very hard to convince others that his story, among all others of the day, was at long last the proof of a Grand Design in the mind of God. The age of prefect prediction, it seemed, was upon us. All that remained was to employ rigorous methods of observation, measurement and testing to discover the clockwork "laws" of nature decreed by God, and thus was born the story-telling method of what the authors of *The Grand Design* call, the "classical" physical sciences. "According to the traditional conception of the universe, objects move on well-defined paths and have definite histories. We can specify their precise position at each moment in time."

The disciples of the physical sciences fashioned themselves as a monastic sect, sworn to abide by the codices of the scientific method in their quest for perfect prediction. They adopted the self-consistent and therefore perfectly true language of mathematics as their lingua franca. It was by the example of Newton's physics that all other scientific storytelling became fashioned.

Amongst Newtonian storytellers the heretics of science came to be regarded as those who failed to heed the evidence of the senses revealed in observation and measurement. The nature of the true world, they claimed, can only be revealed if we eschew our beliefs and cleave to the empirical evidence. The history of scientific storytelling then, is the story told of following the evidence gleaned in observation and measurement conducted by ever more powerful technologies such as giant telescopes, electron microscopes, atom smashing accelerators, and brain scanners, and all was good in the quest for truth, until that is, those instruments of scientific observation began to produce evidence in which the creed of falsification itself became falsified.

Say the authors of the Grand Design: "Although [the classical science] account is successful enough for everyday purposes, it was found in the 1920s that this "classical" picture could not account for the seemingly bizarre behavior observed on the atomic and scales of existence"

So where has the latest evidence of our senses realized in natural selection and extended by technological means been leading in the search to discover the ultimate story — *the grand design*?

The evidence of our senses, enhanced and extended, about the nature of things at the smallest and largest scales of experience, seems to conspire to frustrate our best scientific storytellers, forcing them to create bizarre twists and turns of plot in order to make sense of a seemingly endless stream of self-contradictory evidence. On the scale of small, when we try to determine if light behaves as a wave or as particles, the answer depends on how we look at it. The evidence of the wave falsifies the evidence of particles and the evidence of particles falsifies the evidence of waves. The truth of the matter is as slippery as a wet eel.

When we try to determine the location and speed of a subatomic particle we find that the more we know about its location, the less we can know of its speed, and the more we know of its speed, the less we can know of its location. In the three dimensional space of our experience, one prediction precludes another.

When we shoot molecular "Buckyballs" through a slit in a screen, they pile up on the other side, honest and true, unless there are two slits, in which case the piling up is falsified, and the Buckyballs line up like soldiers in rank and file and salute us. Then again, if we peek at one of two slits while shooting the Buckyballs, they lie to us again by piling up as if there were only one slit! The Buckyballs have caught us peeking!

On the scale of the large, as we approach the speed of light, time and space are transformed in a lockstep that leads to the disappearance of both at Einstein's storied terminal velocity, the "constant" speed of light. Location in space and time along with all causes and effects are gone, baby, gone! The very foundation of our stories told in pasts and futures are obliterated.

The mathematics required to construct a story about the falsification of falsification, requires that the world we are observing not proceed along the familiar storylines of the causes and effects that mark our everyday experience in four dimensions. Randomness rules in time and space, if these places exist at all, and bounce around in 11 storied dimensions, and presumably more in some other version. Randomness rules save the evidence that some stories appear to be more probable than others and these probabilities can be practically calculated, say the authors, using the sum of all possible histories, called a Feynman sum.

Now if the "probability amplitude" for one story, teased out from the mathematically calculated 10^{500} possible stories, can be singled out as greater than all the others, it would seem we are at least getting closer to fingering the story of everything we seek, but the evidence throws us still another curve ball. When we swing the bat this time, it turns out that the probabilities we calculate for a story we tell depends on what we chose to observe and how we observe it! "We create the evidence of our story by our observation rather than that story creating us" (p. 140). It does not matter which stories are actually more probable, if any can said to be so, because the story we experience as observers, however improbable, is always the one that results in us!

If the best that we can do is construct the one story, top-down, that leads to us among a multitude of possible stories that lead to universes without us, then we are returned to the center of the universe, which is precisely where we began our journey as human beings in search of perfect prediction.

The evidence, say Hawking and Mlodinow, is that there are no fixed laws of nature "out there". The world that we can observe in knowing is dependent upon the models we use, and the models we can use are determined by the conditions that lead to the one world that allows for us, among on infinitude of possible worlds.

> We form mental concepts of our home, trees, other people, the electricity that flows from wall sockets, atoms, molecules, and other universes. These mental concepts are the only reality we *can* know. There is no model-independent test of reality.

Hawking and Mlodinow do not doubt that there is a world "out there", but in their story they say that the overwhelming weight of evidence based in observation and measurement indicates that there is no one Grand Design within our ken. The Grand Design is "in here". Theirs is a theory about our theory-making. It is a theory about the nature and limits of the process by which we can construct stories in order to make sense of the world and predict as we go about the business of living:

> It might be that to describe the universe we have to employ different theories in different situations. Each theory may have its own version of reality, but according to model-dependent-realism, that is acceptable so long as the theories agree in their predictions whenever they overlap, that is, whenever they can both be applied. (p. 117)

The authors state that their best candidate for the grand design is M-Theory, in which they say the "M" stands for "master", "miracle", or "mystery", but might just as well stand for "many". M-Theory is not a single theory of everything but a theory of theory-making, in which many theories are employed to describe the universe that we observe and each story stands the test of the scientific method of story telling so long as in prediction, it does not contradict the others when their paths cross.

As with all stories, M-Theory must have initial conditions, and the authors triumphantly suggest the following:

> Because gravity shapes space and time, it allows space-time to be locally stable but globally unstable. On the scale of the entire universe, the positive energy of matter *can*

> (in one story) be balanced by the negative gravitational energy, and so there is no restriction on the creation of whole universes. (p. 180)

How useful is the M-Theory story that allows multiple universes, each governed by its own laws, to be spontaneously generated from lumpy randomness? What are its practical implications for the human enterprise? The authors say,

> We seem to be at a critical point in the history of science, in which we must alter our conception of goals of what makes a physical theory acceptable. It appears that the fundamental numbers, and even the form, of the apparent laws of nature are not demanded by logic or physical principle. The parameters are free to take on many values and the laws to take on any form that leads to a *self-consistent* mathematical theory, and they do take on different values and different forms in different universes. (p. 143)

The turning point in our journey in search of *the grand design* is that both the evidence and the story, as best as we can tell it, is that many if not an infinite number of stories are possible, and, given the questions we ask, some of the stories we construct will work better than others, though none can ever be perfect. The business of science, it would seem, must be transformed from the search for external truth into a search for stories that serve our purposes as creatures who make their living in prediction.

At the beginning of their book, the authors claim that their scientific storytelling has led to the end of philosophy, but in many ways their journey brings them full circle. It is more likely that the end of their story marks the beginning of another — one that attempts to unravel the question of what our purposes as predictive creatures might best be. And in the final analysis, that story can only be crafted in philosophical terms.

As with the king and his trusted advisor in the parable proffered at the beginning of this review, the evidence indicates that we are condemned to live in a kingdom of lies, in which the predictive stories we create always begin and end with us at their center. The best we can do is to place a mark upon our foreheads to remind us that we are mad and get on with the business of making our lies as useful as possible.