The Seven Secrets of How to Think Like a Rocket Scientist

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Copernicus Books
An Imprint of Springer Science+Business Media

Published in the United States by Copernicus Books,
an imprint of Springer Science+Business Media.

Copernicus Books
Springer Science+Business Media
233 Spring Street
New York, NY 10013
www.springer.com

Library of Congress Control Number:
2006922755

Manufactured in the United States of America.
Printed on acid-free paper.

9 8 7 6 5 4 3 2 1

ISBN-10: 0-387-30876-8
ISBN-13: 978-0-387-30876-0

Acknowledgments

I'd like to thank all those who contributed to this book by their positive support, their helpful suggestions, and their sharp eyes for typos. Among these are my friends and colleagues Dr. James R. Wertz and Professor Tasos Lyrintzis; Purdue graduate students Janelle Boys, K. Joseph Chen, Karl Garman, Damon Landau, Kristin Medlock, Masataka Okutsu, Tracey Smith, Christoph Wagner, and Chit Hong "Hippo" Yam; my brother, Joseph A. Longuski, and my mother, Jeanette T. Longuski, and Ronit Binder, Dr. Michael Jokic, Dr. T. Troy McConaghy, Elma Witty, and Wendy Witty.

I thank my secretary, Karen L. Johnson, for her work in typing the corrections and for several thoughtful improvements. I thank doctoral candidate Mr. Masataka Okutsu for his delightful interior and cover illustrations. I also thank Dr. Harry (J.J.) Blom and Mr. Chris Coughlin (senior editor and assistant editor for astronomy & astrophysics at Springer) and Mr. Michael Koy (senior production editor at Springer) for promoting the publication of my book and for their kindness and patience throughout the process. Thanks also to freelance editor Paul Farrell for his advice and counsel, and to graphics consultant Jordan Rosenblum for making the cover and interior designs sparkle.

I hasten to add that the individuals named here (and those who have written encomia for the book) do not necessarily agree with all the opinions expressed by the author.

Above all, I thank my wife and best friend, Holly C. Longuski, who has given me the greatest encouragement and support.

Contents

Introduction

This is a book for the armchair thinker. There are no equations, no syllogisms, and no exercises with the solutions at the back of the book.

It is written not for rocket scientists (although they might enjoy it, too) but for the non–rocket scientist.

Before I wrote this book, I asked a number of people what they hoped to find in a book about how to think like a rocket scientist. "Do you want to know what rocket scientists actually think about and have it translated into ordinary language?" I asked, and everyone said, "No."

"Then would you prefer to know the methods that rocket scientists use—not the content—expressed in a way that you could apply to your everyday life?"

And then everyone said, "Yes."

The book you are holding does just that. (Mostly.)

Let me tell you the first secret about rocket scientists. They are not in it for the money. They are in it for the fun. They are the biggest dreamers on Earth because they dream on a cosmic scale. And they love sci-fi books and movies. Sometimes, the dopier the movie, the better they like it.

That's why I start Part I with "Dream." Dreaming about space travel is what makes rocket scientists tick. I end with Part VII, "Do," because the best part about rocket science is when those dreams come true. I give seven secrets of how to think like a rocket scientist as active verbs: "Dream," "Judge," "Ask," "Check," "Simplify," "Optimize," and "Do."

I talk about how we can all use some of the thinking techniques that rocket scientists learned from the extraordinary challenges of

space exploration. This doesn't mean that rocket scientists are all geniuses or that they never make mistakes. They have been humbled often enough by catastrophic explosions, destruction of billion-dollar satellites, and loss of life.

A great deal of effort is put into avoiding mistakes because mistakes are so costly. But some of the greatest lessons came from the worst failures.

The best known rule of thumb in the space business is Murphy's law: "If something can go wrong—it will!" Space history revolves around the struggle of beating Murphy's law.

In this book, I have written several short chapters about each of the seven secrets of how to think like a rocket scientist. I illustrate the principles with anecdotes, quotations and biographical sketches of famous scientists, ideas from sci-fi, personal stories and insights, and occasionally a bit of space history. At the back of the book, I give, not the solutions to brain teasers, but instead a list of imagination builders: my list of the greatest science fiction movies of the twentieth century. (The jury is still out on the twenty-first century.) I also provide a Recommended Reading and Bibliography list.

In the course of writing this book, I found it necessary to distinguish between "two NASAs": the NASA that put men on the moon and the NASA that built the space shuttle. From the original NASA, we can learn how to think like rocket scientists. Unfortunately, the latter NASA provides examples of how not to think like rocket scientists. Because my goal is to provide you, the reader, with thinking techniques distilled from the space program, I draw from the historical record—good and bad. I hasten to add that my occasional criticism of NASA as an institution in no way diminishes my admiration for its highly qualified scientists, engineers, technicians, and staff—some of the best talent in the world—who yearn for far greater challenges (and the requisite funding) to explore space.

I hope you enjoy this little collection of ideas and find some of the techniques useful.

PART I

Dream

"His adventure began with a dream . . . Robert Goddard had a waking dream about flying farther than anyone ever had, to other worlds in the sky."

David A. Clary
Rocket Man

1

Imagine It

If you could not fail, what would you attempt?

Forget about your fears, the facts, looking silly or stupid—and test your ability to dream.

Albert Einstein said that imagination is more important than knowledge. Why would he say something so contrary to his pursuit of scientific truth? To free his imagination. To suspend his fear of being wrong—for a while—and to dream how the universe might be.

What would you dream?

Rocket scientists have their answer. Rocket scientists love science fiction novels and movies: stories about traveling to Mars, Jupiter, Alpha Centauri, the Andromeda Galaxy; about contact with alien beings, many-tentacled monsters, conscious robots, and giant ants (or spiders or locusts or gorillas). Their favorite books are not literature. Their favorite films are the exemplars of B-grade movies. So what does this demonstrate about rocket scientists?

They aren't afraid of looking silly.

How can a rocket scientist who has remotely piloted a deep space probe to the outer fringes of the solar system enjoy the 1950 film *Destination Moon*, which tenders a juvenile plot, serves up wooden dialogue, and features cheesy special effects?

Let's take a closer look at a group of such rocket scientists who worked for a prestigious government laboratory. On a regular basis, they would meet for a "Sci-Fi Film Festival" in which they'd watch 1950s videos. They'd watch such classics as *The Day the Earth Stood Still* and *Forbidden Planet* and such crap as *Plan 9 From Outer Space* and *I Married A Monster From Outer Space*. They memorized lines

like "Gort, Klaatu barada nikto!" (what to say to the robot to stop him from vaporizing you) and "The fool—to think that his ape-brain could contain the secrets of the Krell!" (what Dr. Morbius said to the rescue ship's doctor who took the IQ boost). They'd laugh at the bad navigation in *Rocketship X-M* where the spacecraft "accidentally" goes to Mars instead of the moon.

But they loved these films.

They were like children who want to hear the same fairy tale over and over again. These were the fairy tales of the rocket scientists; their unfettered hearts seeking contact with outer space. Their logic turned off (their humor kept on)—their dreams turned on.

Imagination wasn't silly to them.

2

Work on the Big Picture

In *Advice to Rocket Scientists*, I talk about two bricklayers who are asked by a young boy what they are doing. The first bricklayer is annoyed at the question and says, "Can't you see? I'm laying bricks." The second says with a gleam in his eye, "I'm building a cathedral!"

The first bricklayer was a little-picture person. All he could see was the tedious job of laying one brick at a time. The second bricklayer was a big-picture person. He envisioned a beautiful cathedral in all its glory and he reveled in his task to help create it.

Find your big picture and it will give your task perspective and joy. The big picture focuses your mind and subconscious on a larger purpose. It gives meaning to all the little tasks you must tend to in order to achieve your goal.

The Chinese philosopher Lao Tse said that "a journey of a thousand miles begins with a single step." If we could ask him where he was going, he'd probably describe a distant land of great enchantment. If we could ask him how he expected to get there, he'd demonstrate silently by taking another step. Keep your big picture in mind when solving your problems. The big picture will help you take the next step—it will give you direction.

Albert Einstein was always looking for the most general theory to explain how the universe operates. He explained the mysterious constancy of the speed of light by his special theory of relativity. In this case "special" meant restricted. Later, he removed the restriction and came up with his general theory of relativity, which explained how gravity works. Einstein then tackled the most

difficult problem of all: to develop a unified field theory to explain not only gravity but all the forces in the universe.

Einstein spent only a few years developing his special theory, a decade for his general theory, and the rest of his life searching for a unified theory. Einstein was a big-picture person. He was not interested in how a particular atom vibrates—he wanted to understand the entire universe. His big picture gave him direction throughout his scientific life. Not all scientists think Einstein was right. But today, many are working on the "theory of everything." Einstein's big picture continues to inspire new generations.

3

Aim High

Rocket scientists aim high. They reach for the moon and beyond. Their dreams are gigantic in scale. They may not always achieve their goals, but they know that you never hit a target that you don't aim at. (As hockey great Wayne Gretsky said, "You miss 100 percent of the shots you don't take.") Sometimes their dreams come true, but even when they don't, the achievements of rocket scientists are great.

Ernest Shackleton, the polar explorer, aimed high. Maybe we should say he aimed low, because his target was the South Pole. In 1902, he traveled with Robert F. Scott to within 460 miles of the pole. In 1908, he commanded his own expedition but was forced back after falling short of the pole by 97 miles. To have gone on to reach his goal would have meant certain death to his crew. Though Shackleton was criticized by some, he considered the safety of his men to be of far greater importance than his stated mission. Scott, who was rigorously trained in the British navy, was of the school that some loss of life was inevitable. Similar arguments have been made in defense of the space shuttle, but as we shall see later, there are better, safer ways to explore space.

On December 14, 1911, Shackleton's dream was dashed when Roald Amundson of Norway reached the South Pole. One month later, Scott and his party reached the pole but died on their return trip. In the next few years, Shackleton, undaunted by the success of Amundson, planned a daring adventure: the first transcontinental expedition of Antarctica.

In the attempt he made his greatest failure. He lost his ship but saved every member of his crew in a dramatic two-year