What I Did this Summer:

True Confessions of an NKS Summer School Student

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It is not knowledge, but the act of learning, not possession but the act of getting there, which grants the greatest enjoyment.

-- Karl Friedrich Gauss

Introduction

For much of the Summer of 2003, I attended a school hosted by Dr. Stephen Wolfram, noted scientist and author of *A New Kind of Science*. Dr. Wolfram and his staff devised the school as a way to inform and educate a broad community about the inner workings of his theories, and to promote their use.

Figure 1. The author, unshaven, sleep-deprived, and loving every minute of it.

I have had so many people ask me about my experience at the school that I have decided to lay down my thoughts on paper. The following is an account of that personal journey, as well as a discussion of where I go from here.

A New Kind of Science (NKS)

From his early days, Dr. Wolfram maintained a fascination with the power of simple programs – that is, computational structures that execute a set of finite, simple rules over and over again to produce a result. In its most basic form, one may think of a grid of cells against a wall, which may be colored black or white, operating on one row at a time in downward fashion. The rules dictate the color, using instructions like "if the cell directly above me in the prior row was black, then color me white". The rules are applied row by row across many iterations. The great surprise was the fact that some very elementary rules such as these produced remarkably complex forms and structures. If this is the case, Wolfram reasoned, perhaps the origin of many of the complex organisms and matter that we observe in the real universe can be attributed to simple underlying rules.

To say that this was a controversial idea is to say that Barry Bonds can hit a baseball. Many leading academicians called Wolfram's work "pseudoscience", in part because it was done in isolation – away from the peer review processes common in scientific research.

Strangely, this controversy *increased* my interest in Wolfram's work. I had no ability to judge the merit of the science – yet, I was drawn to the promise of explaining the unexplainable – highly complex, seemingly random phenomena around us every day – the stock market, the weather, shapes of leaves and snowflakes, war, politics, disease. Could this be the key to unlock these mysteries? I couldn't rely on the experts…I had to find out for myself.

The School

A fortunate 50-odd students were selected from over 800 applicants. The school was held in picturesque Providence, Rhode Island, on the campus of Brown University. The leafy campus and the ocean nearby made for a natural "contemplative" setting for deep thought. The day was oriented around lectures from Wolfram himself and staff as well as work on the self-assigned research project.

I decided early on that I wanted to do a business-oriented project. After all, my interest in business was the difference between me and my fellow students, most of whom were graduate and doctoral students in the classical sciences. The mysteries of business, my thinking went, could finally be cracked using the new lenses that Wolfram has provided us. This seemed right to me, as many of the complexities of the physical world were direct analogies to business. My research and results can be found at the following address: http://www.wolframscience.com/summerschool/2003/participants/danner.html.

The students were an odd (let's call it diverse) collection of academicians from biology to economics to physics to astronomy to computer science to mathematics, ranging in age from recent graduate to, uh…well, me.

One student was a high school mathematics teacher (department head, to be precise). His goal was to devise some experiments in NKS to take into the classroom. Think about that for a moment: high school students running simple program models to use to understand facets of biology, physics, astronomy…this is quite possibly revolutionary in the way we educate our young. Moreover, we have a chance to instill NKS concepts in young people who may in turn create a generation of "modeling mindsets". Stay tuned.

After three weeks, the school was over. We heard presentations from all of the students on their research projects, some with amazingly comprehensive material, sufficient for a university-quality research paper. It was fascinating to see the myriad ways NKS was woven into disciplines as diverse as biology, economics, physics - even art!

So What is Stephen Wolfram Like?

In spite of media accounts to the contrary, Dr. Wolfram is warm, open, and personable. He shared with us his personal stories as a young scientist – his triumphs and his failings. He told of his pilgrimage to the hometown of Dr. Alan Turing, a WWII-era scientist and father of the modern computer, where he studied his personal notes and archives. He

spoke of his colleague and mentor, the late Richard Feynman, a Nobel-prize winning physicist from Caltech.

One night, Dr. Wolfram gave a public lecture to Brown students. Given that this was the middle of summer, the only students at Brown were freshly graduated from high school and attending orientation courses. One might think that such students would not be the optimal audience for an NKS lecture.

Nonetheless the students, numbering about 200, largely listened quietly and politely over the course of the ninety minute lecture. The big surprise came in the Q&A session, where one student bravely offered his homework assignment (to compute a very large prime number) to Dr. Wolfram to solve. In true Wolfram style, the good doctor strode back to his computer at the podium, homework in hand, and proceeded to compute the answer to the question, in several long pages of Mathematica output. The students were on the verge of a standing ovation. Dr. Wolfram then went on to an ever-escalating tour of the graphical features of Mathematica. Afterwards, Dr. Wolfram was mobbed by a horde of bright-eyed students, like a rock star after the closing act. It was pure magic.

Truly the highlight of the school was the off-the-cuff remarks by Wolfram on everything from starting a business to how to write a research paper. His engaging personal stories were the source of the some of the best teaching one could possibly have. Perhaps most impressive, Dr. Wolfram spent time one-on-one with each and every student. This was quite a treat. Like a doctor assessing a patient, he would carefully listen to our proposals for study, then offer remarkably keen insight into how to approach the problem. He flowed seamlessly from theoretical physics to computer science to biology to philosophy. Maybe the true measure of intelligence is one's ability to get outside of one's field, yet still be capable of commanding insight through deep and powerful thought processes. Wolfram is wired quite differently from the rest of us mortals.

The Future of NKS

As of this writing the next NKS Conference and Summer School are being planned. Numerous initiatives such as the NKS Atlas (a compendium of interesting simple program instances) and NKS Forum are already underway. The machinery of NKS development is in motion. While it will take some time before we see the fruits of these labors, I suspect that something "significant" with NKS will show itself in less than one year from now, far sooner than even Wolfram himself estimates.

Summary

I cannot adequately describe the honor I feel having been through the inaugural school in NKS, and the experience of working directly with Dr. Wolfram and his brilliant staff. It is as if I have been given a rare set of eyeglasses, through which only I and a handful of others are allowed to see – where the fuzzy becomes sharp, where everyday life is strangely understandable, where it was simply disparate puzzle pieces before.

Where will this journey take me? Hard to say. All that I know for certain is that I find myself drawn to the path itself, like a sailor drawn to the sea. For indeed this is truly a new kind of science, and the future may well belong to those who embrace its teachings. I think Gauss would approve.◘

About the Author

George E. Danner is Principal and Founder of Industrial Science, LLC, a consultancy specializing in applying quantitative methods and simulation modeling to highly complex business problems. His particular specialty lies in agent-based simulation modeling, Monte Carlo simulation, System Dynamics, Game Theory, and Real Options. George has twenty years of experience in corporate strategy, including both operational and financial analysis, across a wide variety of industries, including manufacturing, energy, telecommunications, transportation, and financial services. Prior to founding Industrial Science, George was a leader in the US National Strategy Practice of Arthur Andersen Business Consulting, based in Houston, Texas, USA.

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