Chapter 1

Lessons From a Twisted Career Path

by Jeffrey S. Rosenthal[1]

Abstract. I reflect upon my academic career path that ultimately led to receiving the COPSS Presidents' Award, with the hopes of providing lessons and insights for younger researchers.

1.1   Introduction

On a chilly Toronto evening in February, 2007, my wife and I returned home from a restaurant. My wife went into the kitchen to put some leftovers in the fridge, while I flopped onto the couch and absent-mindedly picked up a laptop computer to check my e-mail. A minute later my wife heard a dazed and confused "Oh my god!", and rushed back in to see what was wrong. I was barely able to mutter that, to my amazement, I had just been selected to receive that year's COPSS Presidents' Award.

The e-mail message talked mostly about boring details, like the importance of my keeping my award "STRICTLY CONFIDENTIAL" until the official announcement (over five months later!). And the award's web page focused more on its sponsorship and eligibility requirements than on its actual meaning and value. But none of that mattered to me: I knew full well that this award was a biggie, generally regarded as the world's top academic prize in Statistics. I couldn't believe that they had chosen me to receive it.

Six years later, I still can't.

I was struck then, as I often am, by my career's twists and turns: how some of the most interesting developments were also the least expected, and how unlikely it would have seemed that I would ever win something like the COPSS. In fact, I never set out to be a statistician at all.

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Many young statisticians picture COPSS winners as having clear, linear career paths, in which their statistical success was always certain. In my case, nothing could be further from the truth. So, in this article, I will reflect upon some of the twists and turns of my academic career to date, with the hopes of providing lessons and insights (written in **boldface**) for younger researchers.

1.2 Student Days

I was an undergraduate student at the University of Toronto from 1984 – 1988. What I remember most from those years is the huge *excitement* that I felt at being surrounded by so much knowledge and learning. I would run enthusiastically to lectures and meetings, unable to wait for what I would learn next. In addition to my regular classes, I took or audited courses in other subjects of interest (astronomy, chemistry, philosophy, linguistics), joined various clubs and activities, socialized a great deal, played music with friends, developed my spoken French, went on fantastic camping and canoeing trips, and discussed everything with everyone. Around that time, a high school acquaintance (in fact, the young lady that I had taken to my high school prom) remarked that she saw me on campus from time to time, but never managed to talk to me, since I was always rushing off to somewhere else.

Subsequent years of pressure and deadlines have somewhat dulled that initial sense of excitement, but I can still feel and remember it well, and it has carried me through many difficult times. Indeed, if I could give just one piece of advice to students and young academics, it would be this: **Maintain your enthusiasm about learning as much as you can about everything. With enough excitement and passion, everything else will follow.**

In my undergraduate studies, I concentrated primarily on pure mathematics and physics, with some computer science on the side. You will notice that "statistics" has not been mentioned here. Indeed, I am **a COPSS winner who never took a single statistics course.** I did, however, benefit tremendously from the **rigorous mathematical training** that I received instead.

1.2.1 Applying to Graduate School

When my undergraduate studies were coming to an end, I was excited to apply to graduate programs. All around me, students were rambling on about being unsure what they wanted to study or what they would do next. I scoffed at them, since I already "knew" what I wanted to study: mathematical analysis with applications to physics! (Statistics never even crossed my mind.)

Despite my successful undergraduate years, I fretted enormously over my grad school applications, applying to loads of programs, wondering what my professors would write about me, thinking I wouldn't get accepted, and so on. That's right: **Even future COPSS winners worry about succeeding in academics.**

My math professors advised me that, while there were many good mathematics graduate programs, the *best* one was at Princeton University. So, I was amazed and delighted to receive a letter accepting me into their PhD program! They even offered a bit of money to help me visit their campus before deciding. So, although I "knew" that I was planning to accept their offer, I found myself on a flight to Newark to visit the famous Princeton campus.

And then a funny thing happened. My visit made me very *depressed*. It did reinforce the amazing research depth of the Princeton math faculty. But none of the PhD students there seemed *happy*. They felt a lot of pressure to write very deep doctoral theses, and to finish in four years. They admitted that there wasn't much to "do" at Princeton, and that everyone spent all their time on work with little time for fun. (I asked one of them if there were clubs to go hear music, but they didn't seem to even understand my question.)

I returned to Toronto feeling worried about my choice, and fearing that I might be miserable at Princeton. At the same time, I wondered, did it really make sense to consider such intangible factors when making important academic decisions? I finally decided that the answer was yes, and I stand by that conclusion today: **It is perfectly reasonable to balance personal preferences against academic priorities.**

So, I decided to consider other graduate schools too. After some more travel and much agonizing, I enrolled in the Harvard University mathematics PhD program. Harvard also had incredible mathematical research depth, including in mathematical physics, and in addition it was in a fun-seeming city (Boston) with students who seemed to find at least a bit of time to enjoy themselves.

I had made a decision. I had even, I think, made the *right* decision. Unfortunately, I wasn't *sure* I had made the right decision. Now, it should be obvious that: **Once you have made a decision, stick with it and move on; don't waste time and effort worrying about whether it was correct.** But I didn't follow that advice. For several years, I worried constantly, and absurdly, about whether I should have gone to Princeton instead.

1.2.2   Graduate School Beginnings

And so it was that I began my PhD in the Harvard mathematics department. I struggled with advanced mathematics courses about strange-seeming abstract algebraic and geometric concepts, while auditing a physics course about the confusing world of quantum field theory. It was difficult, and stressful, but exciting too.

My first big challenge was the PhD program's comprehensive examination. It was written over three different afternoons, and consisted of difficult questions about advanced mathematical concepts. New PhD students were encouraged to take it "on a trial basis" just months after beginning their program. I did my best, and after three grueling days I thought I was probably "close" to the passing line. The next week I nervously went to the graduate secretary's office to learn my result. When she told me that I passed (unconditionally), I was so thrilled and amazed that I jumped up and down, patted various office staff on

their shoulders, raced down to the departmental library, and danced in circles around the tables there. I couldn't believe it.

Passing the comps had the added bonus that I was henceforth excused from all course grades. Three months after arriving at Harvard, "all" I had left to do was write my PhD thesis. Easy, right?

No, not right at all. I was trying to learn enough about state-of-the-art mathematical physics research to make original contributions. But the research papers on my little desk were so difficult and abstract, using technical results from differential geometry and algebraic topology and more to prove impenetrable theorems about 26-dimensional quantum field theories. I remember looking sadly at one such paper, and estimating that I would have to study for about two more years to understand its *first sentence*.

I got worried and depressed. I had thought that applications of mathematics to physics would be concrete and intuitive and fun, not impossibly difficult and abstract and intangible. It seemed that I would have to work so hard for so many years to even have a *chance* of earning a PhD. Meanwhile, I missed my friends from Toronto, and all the fun times we had had. I didn't see the point of continuing my studies, and considered moving back to Toronto and switching to something more "practical" like computer programming. That's right: **A COPSS winner nearly dropped out of school.**

1.2.3   Probability to the Rescue

While beating my head against the wall of mathematical physics, I had been casually auditing a course in probability theory given by Persi Diaconis. In contrast to all of the technical mathematics courses and papers I was struggling with, probability with Persi seemed fun and accessible. He presented numerous open research problems which could be understood (though not solved) in just a few minutes. There were connections and applications to other subjects and perhaps even to the "real world". I had little to lose, so I nervously asked Persi if I could switch into probability theory. He agreed, and there I was.

I started a research project about random rotations in high dimensions – more precisely, random walks on the compact Lie group $SO(n)$. Although today that sounds pretty abstract to me, at the time it seemed relatively concrete. Using group representation theory, I got an initial result about the mixing time of such walks. I was excited, and told Persi, and he was excited too. I hoped to improve the result further, but for a few weeks I mostly just basked in the glory of success after so much frustration.

And then a horrible thing happened. I realised that my result was wrong! In the course of doing extensive calculations on numerous scraps of paper, I had dropped an "unimportant" constant multiplier. One morning it suddenly occurred to me that this constant couldn't be neglected after all; on the contrary, it nullified my conclusion. In short: **A COPSS winner's first research result was completely bogus.**

I felt sick and ashamed as I informed Persi of the situation, though fortunately he was very kind and understanding. It did teach me a lesson, that I

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don't always follow but always should: **When you think you have a result, write it down very <u>carefully</u> to make sure it is correct.**

After that setback, I worked very hard for months. I wrote out long formulas for group representation values. I simplified them using subtle calculus tricks, and bounded them using coarse dominating integrals. I restricted to a particular case (where each rotation was 180 degrees through some hyperplane) to facilitate computations. Finally, hundreds of pages of scrap paper later, I had actually proved a theorem. I wrote it up carefully, and finally my first research paper[2] was complete. I knew I had a long road ahead – how long I could not estimate – but I now felt that I was on my way. I enthusiastically attended lots of research seminars, and felt like I was becoming part of the research community.

Over the next couple of years, I worked on other related research projects, and slowly got a few other results. One problem was that I couldn't really judge how far along I was towards my PhD. Did I just need a few more results to finish, or was I still years away? I was mostly too shy or nervous to ask my supervisor, and he didn't offer any hints. I finally asked him if I should perhaps submit my random rotations paper for publication in a research journal (a new experience for me), but he demurred, saying it was "too much of a special case of a special case", which naturally discouraged me further. (As it happens, after I graduated I submitted that very same random rotations paper to the prestigious *Annals of Probability*, and it was accepted essentially without change, leading me to conclude: **PhD students should be encouraged to submit papers for publication.** But I didn't know that then.)

I started to again despair for the future. I felt that if only I could finish my PhD, and get tenure at a decent university, then life would be good. But I wondered if that moment would ever come. Indeed, I was **a future COPSS winner who thought he would never graduate.**

A few weeks later, I was lifted out of my funk by a rather awkward occurrence. One Friday in November 1990, as I was leaving a research meeting with Persi, he casually mentioned that perhaps I should apply for academic jobs for the following year. I was speechless. Did this mean he thought I was already nearly finished my PhD, even while I was despairing of graduating even in the years ahead? I left in a daze, and then spent the weekend puzzled and enthusiastic and worried about what this all meant. When Monday finally came, I sought out Persi to discuss details. In a quick hallway conversation, I told him that if he really did think that I should apply for academic jobs, then I should get on it right away since some of the deadlines were already approaching. Right before my eyes, he considered for several seconds, and then changed his mind! He said that it might be better for me to wait another year instead.

This was quite a roller-coaster for me, and I've tried to remember to **be as clear as possible with PhD students about expectations and prognoses.** Nevertheless, I was delighted to know that at least I would (probably) graduate the following year, i.e. after a total of four years of PhD study. I was thrilled to see light at the end of the tunnel.

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[2]All of the author's research papers mentioned here are available at `www.probability.ca`.

Finally, the next year, I did graduate, and did apply for academic jobs. The year 1992 was a bad time for mathematical employment, and I felt pessimistic about my chances. I didn't even think to include my full contact information in my applications, since I doubted anyone would bother to contact me. Indeed, when the photocopier added huge ink splotches to some of my application materials, I almost didn't bother to recopy them, since I figured no one would read them anyway. Yes, **a future COPSS winner barely even <u>considered</u> the possibility that anyone would want to offer him a job.**

1.3   Becoming a Researcher

To my surprise, I did get job offers after all. In fact, negotiating the job interviews, offers, terms, and acceptances turned out to be quite stressful in and of itself – I wasn't used to discussing my future with department chairs and deans!

Eventually I arranged to spend 1.5 years in the Mathematics Department at the University of Minnesota. They had a large and friendly probability group there, and I enjoyed talking with and learning from all of them. **It is good to be part of a research team.**

I also arranged that I would move from Minnesota to the Statistics Department at my *alma mater*, the University of Toronto. I was pleased to return to the city of my youth with all its fond memories, and to the research-focused (though administration-heavy) university. On the other hand, I was joining a Statistics Department even though **I had never taken a statistics course.**

Fortunately, my new department did not try to "mold" me into a statistician; they let me continue to work as a mathematical probabilist. I applaud them for this, and have come to believe that **it is always best to let researchers pursue interests of their own choosing.**

Despite the lack of pressure, I did hear more about statistics (for the first time) from my new colleagues. In addition, I noticed something interesting in the way my research papers were being received. My papers that focused on technical/mathematical topics, like random walks on Lie groups, were being read by a select few. But my papers that discussed the theory of the newly-popular *Markov chain Monte Carlo (MCMC)* computer algorithms, which Persi with his usual foresight had introduced me to, were being cited by lots of statistical researchers. This caused me to focus more on MCMC issues, and ultimately on other statistical questions too. Of course, research should never be a popularity contest. Nevertheless, **it is wise to work more on research questions which are of greater interest to others.**

In my case, these reactions led me to focus primarily on the theory of MCMC, which served me very well in building my initial research career. I still considered myself a probabilist (indeed, I recall someone referring to me as "a statistician" around that time, and me feeling uncomfortable with the designation), but my research more and more concerned applications to statistical algorithms. I was publishing papers, and working very hard – my initial small office was right off the main hallway, and colleagues commented about seeing my light still on

at 10:30 or 11:00 many evenings. Indeed, **research success always requires lots of hard work and dedication.**

1.3.1   Footprints in the Sand

My interactions with the research community developed a slightly odd flavor. MCMC users were aware of my work and would sometimes cite it in general terms ("for related theoretical issues, see Rosenthal"), but hardly anyone would read the actual *details* of my theorems. Meanwhile, my department was supportive from a distance, but not closely following my research. My statistics colleagues were working on questions that I didn't have the background to consider. And probability colleagues wouldn't understand the statistical/MCMC motivation and thus wouldn't see the point of my research direction. So, despite my modest research success, I was becoming academically somewhat isolated.

That was to change when I met Gareth Roberts. He was a young English researcher who also had a probability background, and was also studying theoretical properties of MCMC. The summer of 1994 featured three consecutive conferences that we would both be attending, so I looked forward to meeting him and exploring common interests. Our first encounter didn't go well: I finally cornered him at the conference's opening reception, only to hear him retort "Look, I've just arrived from England and I'm tired and jetlagged; I'll talk to you tomorrow." Fortunately the next day he was in better form, and we quickly discovered common interests not only in research, but also in music, sports, chess, bridge, jokes, and more. Most importantly, he had a similar (though more sophisticated) perspective about applying probability theory to better understand the nature and performance of MCMC. We developed a fast friendship which has now lasted through 19 years and 33 visits and 38 joint research papers (and counting). Gareth has improved my research career and focus immeasurably; **social relationships often facilitate research collaborations.**

My career still wasn't all smooth sailing. Research projects always seemed to take longer than they should, and lead to weaker results than I'd hoped. **Research, by its very nature, is a slow and frustrating process.** Around that time, one of my PhD students had a paper rejected from a journal, and shyly asked me if that had ever happened to me. I had to laugh; of course it did! **Yes, even COPSS winners get their papers rejected. Often.** Nevertheless, I was getting papers published and doing okay as a researcher – not making any huge impact, but holding my own. I was honored to receive tenure in 1997, thus fulfilling my youthful dream, though that did lead to a depressing few months of drifting and wondering "what should I do next". A very unexpected answer to *that* question was to come several years later.

1.3.2   The General Public

Like many mathematical researchers, sometimes I felt frustrated that I couldn't easily explain my work to non-academics (joking that I was the guy no one wanted to talk to at a party), but I had never pursued this further. In 2003,

some writers and journalists in my wife's family decided that I should write a probability book for the *general public*. Before I knew it, they had put me in touch with a literary agent, who got me to write a few sample chapters, which quickly scored us an actual publishing contract with HarperCollins Canada. To my great surprise, and with no training or preparation, I had agreed to write a book for a general audience about probabilities in everyday life, figuring that **it is good to occasionally try something new and different.**

The book took two years to write. I had to constantly remind myself that writing for a general audience was entirely different from writing a research paper or even a textbook. I struggled to find amusing anecdotes and catchy examples without getting bogged down in technicalities. Somehow I pulled it off: *Struck by Lightning: The Curious World of Probabilities* was published in sixteen editions and ten languages, and was a bestseller in Canada. This in turn led to numerous radio/TV/newspaper interviews, public lectures, appearances in several documentaries, and invitations to present to all sorts of different groups and organizations. Completely unexpectedly, I became a little bit of a "public personna" in Canada. This in turn led to several well-paid consulting jobs (including one involving computer parsing of pdf files of customers' cell phone bills to compare prices), assisting with a high-profile media investigation of a lottery ticket-swapping scandal and publishing about that in the *RCMP Gazette*, serving as an expert witness in a brief to Supreme Court of Canada, and more. **You just can't predict what twists your career will take.**

1.3.3   Branching out: Collaborations

In a different direction, I have gradually started to do more *interdisciplinary* work. As I have become slightly better known due to my research and/or book and interviews, academics from a variety of departments have starting asking me to collaborate on their projects. I have found that it is impossible to "prepare" for such collaborations – rather, you have to **listen carefully and be open to whatever research input your partners require**. Nevertheless, due to some combination of my mathematical and computer and social skills, I have managed to be more helpful than I would have predicted, leading to quite a number of different joint papers. (I guess I am finally a statistician!)

For example, I provided mathematical analysis about generators of credit rating transition processes for a finance colleague. I worked on several papers with computer science and economics colleagues (one of which led to a tricky probability problem, which in turn led to a nice probability paper with Robin Pemantle). I was also introduced to some psychologists working on analysing youth criminal offender data, which began a long-term collaboration which continues to this day. Meanwhile, an economics colleague asked me to help investigate temperature and population changes in pre-industrial Iceland. And a casual chat with some philosophy professors led to a paper about the probability-related philosophical dilemma called *the Sleeping Beauty problem*.

Meanwhile, I gradually developed a deeper friendship with my department colleague Radu Craiu. Once again, social interaction led to discovering com-

mon research interests, in this case concerning MCMC methodology. Radu and I ended up co-supervising a PhD student, and publishing a joint paper in the top-level *Journal of the American Statistical Association (JASA)*, with two more papers in preparation. Having a longer-term collaborator within my own department has been a wonderful development, and has once again reminded me that **it is good to be part of a research team.**

More recently, I met a speech pathologist at a lecture and gave her my card. She finally e-mailed me two years later, asking me to help her analyse subjects' tongue positions when producing certain sounds. Here my undergraduate linguistic course – taken with no particular goal in mind – was suddenly helpful; **knowledge can provide unexpected benefits.** Our resulting collaboration led to a paper in the *Journal of the Acoustical Society of America*, a prestigious journal which is also my second one with the famous initials "JASA".

I was also approached by a law professor (who was the son-in-law of a recently-retired statistics colleague). He wanted to analyze the text of supreme court judgments, with an eye towards determining their authorship: did the judge write it directly, or did their law clerks do it? After a few false starts, we made good progress. I submitted our first methodological paper to *JASA*, but they rejected it quickly and coldly, saying it might be more appropriate for an educational journal like *Chance*. That annoyed me at the time, but made its later acceptance in the *Annals of Applied Statistics* all the more sweet. A follow-up paper was published in the *Cornell Law Review*, and later referred to in the *New York Times*, and more related publications are on the way.

These collaborations were all very different, in both content and process. But each one involved a personal connection with some other researcher(s), which after many discussions eventually led to worthwhile papers published in high-level research journals. I have slowly learned to always be on the lookout for such connections: **Unexpected encounters and social interactions can sometimes lead to major new research collaborations.**

1.3.4 Hobbies to the Fore

Another surprise for me has been the extent to which my *non*-research interests and hobbies have in turn fed my academic activities in unexpected ways.

As a child I did a lot of computer programming of games and other silly things. When e-mail and bulletin boards first came out, I used them too, even though they were considered unimportant compared to "real" computer applications like numerical computations. I thought this was just an idle past-time. Years later, computer usage has become very central to my research and consulting and collaborations: from Monte Carlo simulations to text processing to internet communications, I couldn't function without them. And I've been helped tremendously by the skills acquired through my "silly" childhood hobby.

I'd always played a lot of music with friends, just for fun. Later on, music not only cemented my friendship with Gareth Roberts, it also allowed me to perform at the infamous Bayesian conference "cabarets" and thus get introduced to more top researchers. In recent years, I even published an article about the

mathematical relationships of musical notes, which in turn gave me new material for my teaching. Not bad for a little "fun" music jamming.

In my late twenties I studied improvizational comedy, eventually performing in small local comedy shows. Unexpectedly, improv's attitude of "embracing the unexpected" helped me to be a more confident and entertaining teacher and presenter, turning difficult moments into humorous ones. This in turn made me better at media interviews when promoting my book. Coming full circle, I was later asked to perform musical accompaniment to comedy shows, which I continue to this day.

I'd always had a strong interest in Canadian electoral politics. I never dreamed that this would impact my research career, until I suddenly found myself using my computer skills to analyse polling data and projections from the 2011 Canadian federal election, leading to a publication in the *Canadian Journal of Statistics*.

Early in my teaching career, I experimented with alternative teaching arrangements such as having students work together in small-groups during class time. (Such practices are now more common, but back in the early 1990s I was slightly ahead of my time.) To my surprise, that eventually led to a publication in the journal *Studies in Higher Education*.

In all of these cases, topics I had pursued on their own merits without connection to my academic career, turned out to be useful in my career after all. So, **don't hesitate to pursue diverse interests – they might turn out to be useful in surprising ways**.

1.4   Final Thoughts

Despite my thinking that I "had it all planned out", my career has surprised me many times over. I never expected to work in statistics. I had no idea that MCMC would become such a central part of my research. I never planned to write for the general public, or appear in the media. And I certainly never dreamed that my music or improv or political interests would influence my research profile in any way.

Nevertheless, I have been very fortunate: to have strong family and educational foundations, to attend top-level universities and be taught by top-level professors, and to have excellent opportunities for employment and publishing and more. I am very grateful for all of this. And, it seems that my ultimate success has come *because* of all the twists and turns along the way, not in *spite* of them. Perhaps that is the real lesson here – that, like in improv, we should not fear unexpected developments, but rather embrace them.

My career, like most, has experienced numerous research frustrations, rejected papers, and dead ends. And my university's bureaucratic rules and procedures sometimes make me want to scream. But looking back, I recall my youthful feeling that if only I could get tenure at a decent university, then life would be good. I was right: it has been.