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To Arthur Szathmary
with affection and gratitude

Indiscrete Thoughts

Gian-Carlo Rota

Fabrizio Palombi
Editor

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Contents

Part II. Philosophy: A Minority View

Part III Readings and Comments

Foreword

Reuben Hersh

If you're about to buy this book, you're in for a treat.

I first met Gian-Carlo in the late 70's in Las Cruces, New Mexico. He was there to lecture on his mathematical specialty, combinatorics—how to count complicated finite sets, and extensions of that problem. I repeated inaccurately what I had heard from my honored mentor, Peter Lax of New York University.

"A lecture by Rota is like a double martini!"

It was true. Even to one innocent of combinatorics, his lectures were a delightful combination, both stimulating and relaxing.

There are mathematicians who give great lectures, but write dull, ponderous books. There are some who write beautiful books and give dull lectures. (No names will be mentioned). Gian-Carlo gives brilliant lectures, and his writing is as good. He loves contradiction. He loves to shock. He loves to simultaneously entertain you and make you uncomfortable.

His personal history is rare. He was born in Italy of an architect father who was a leading member of Mussolini's secret hit list. Educated first in Ecuador, then at Princeton and Yale. Started research in a "hot" speciality, functional analysis. Underwent an epiphany and conversion to discrete math—the hard-nosed, down-to-earth stuff—but done from the abstract, high level view point of functional analysis. Developed a major interest in the thought of Husserl, Heidegger and Sartre—phenomenology. With it, a distaste for "analytic philosophy," the ruling trend in Anglo-America.

When he started to teach phenomenology at M.I.T., students wanted "philosophy credit" for his course. The M.I.T. philosophers (analytic, of course) said, "Never," and offered to quit en masse. Jerry

Wiesner, the President, told them, "Go ahead, that will help my budget." They didn't quit. Gian-Carlo's students get philosophy credit.

His large Cambridge apartment has enough bookshelves for many a library, but books are all over everything. I'm not sure he sleeps. Certainly he keeps late hours, reading, writing, doing email, talking on the phone, and thinking.

He has a talent for friendship. Some of my warmest memories are dinners at the home of Stan and Françoise Ulam in Santa Fe, with Gian-Carlo and Mark Kac.

He did me a great service, for which I'd like to thank him again. My first piece on the philosophy of mathematics was rejected, on the advice of a prestigious Harvard philosopher. Gian-Carlo immediately printed it in *Advances in Mathematics*, an absolutely tip-top high-class journal published by Academic Press under the founding editorship of G.-C. Rota. Later he started a second organ, *Advances in Applied Mathematics*. His journals' editorial boards boast the highest conceivable quality and prestige. I once mentioned a difference of opinion with the editor at a journal where I was a board member. Gian-Carlo said, "If anyone on my board gave me trouble, I would kick him out." This book ends with some truly inimitable book reviews from the *Advances*.

Before that come three main parts: *Persons and Places, Philosophy, and Indiscrete Thoughts*.

In *Persons and Places* you'll meet great names. You'll learn not only about their contributions, but also about their kindness, their egos, their absurdities. Most mathematicians know Artin, Church, Feller, Lefschetz and Ulam only as names on a book or paper. Gian-Carlo presents vivid, startling images of them, as live human beings, like us! What a shock! What a liberation! I don't know another since Plutarch who attains this balance: deep appreciation of their accomplishments, and honesty about the embarrassing qualities of great men of science.

After the suave raconteur of *Persons and Places,* Gian-Carlo the phenomenologist may come as a shock. The reader may feel lost for a moment. But, as Richard Nixon said in another connection, "When the going gets tough, the tough get going." Phenomenology is one of the seminal forms of thought of our age. You'll make faster headway with Gian-Carlo than with other writers on the subject. And you can look forward to the easy delights of *Indiscrete Thoughts* coming next.

But you're within your rights if you decide to take phenomenology in small doses. The chapter on mathematical beauty is recommended. Everyone knows that in mathematics, beauty is the highest desideratum. But the few attempts to explain what's meant by "mathematical beauty" have been feeble and unconvincing. Gian-Carlo has a new answer. "Beauty in mathematics is enlightenment." When we are enlightened, we think, "How beautiful." This insight is both enlightening and beautiful!

Indiscrete Thoughts is strong medicine. His thoughts about mathematics are usually startling and provocative. His messages to and about mathematicians are provocative beyond indiscretion. Gian-Carlo never pulls his punches. I advise discretion in reading these indiscretions. A few every few hours. Gulping them at one sitting is not recommended.

What's the thread tying together Gian-Carlo the memoirist, the aphorist, and the phenomenologist? He strives to keep his eyes wide open and then tells it the way he sees it, without pretense, and often without prejudice. Always with wit and flair.

Foreword

Robert Sokolowski

There are two erroneous extremes one might fall into in regard to the philosophy of mathematics. In the one, which we could call naive objectivism, mathematical objects, such as the triangle, the regular solids, the various numbers, a proof, or abelian groups, are taken as simply existent apart from the work of mathematicians. They exist whether we discover them or not. In the other, which we could call naive subjectivism or psychologism, mathematical items are taken to be mental constructs of mathematicians, with no more objectivity than the feelings someone might have had when he thought about a rectangle or worked out a proof. The truth, as usual, lies in the middle. Mathematical items are indeed objective. There are mathematical objects, facts, and valid proofs that transcend the thinking of any individual. However, if we, as philosophers, wish to discuss the objectivity of such items, we must also examine the thinkers, the mathematicians, for whom they are objective, for whom they are facts. The philosophy of mathematics carries out its work by focusing on the correlation between mathematical things and mathematicians.

It is in this correlation, this "in between," that Gian-Carlo Rota has developed his own highly original and programmatic philosophy of mathematics. He draws especially but not exclusively on the phenomenological tradition. The point of Husserl's phenomenology, which was further developed by Heidegger, is that things do appear to us, and we in our consciousness are directed toward them: we are not locked in an isolated consciousness, nor are things mere ciphers that are essentially hidden from us. Rather, the mind finds its fulfillment in the presentation of things, and things are enhanced by the truth they display to us. The subjective is not "merely" subjective but presents objectivity to itself. Husserl's doctrine of the "intentionality" of consciousness breaks through the Cartesian straightjacket that has held so much of modern thought captive.

Another principle in phenomenology is the fact that there are different regions of being, different "eidetic domains," as Rota calls them, and each has its own way of being given to us. Each region calls for a correlative form of thinking that lets the things in it manifest themselves: there are, for example, material objects, living things, human beings, emotional facts, social conventions, economic relationships, and political things, and there are also mathematical items, the domain that Rota has especially explored.

One of the phenomena that he develops in this book is that of "evidence." Most people think that in mathematics truth is reached by proof, specifically by deriving theorems from axioms. Rota shows that such proof is only secondary and derivative. It is not the primary instance of truth. More basic than proof is evidence, which is the self-presentation of a given mathematical object or fact. We can know that some things are true, and we can even know that they must be true, before we have found axiomatic proofs to manifest that truth. We know more than we can prove. Rota shows that axiomatic derivations are ways in which we present mathematical objects and facts, ways in which we try to convey the evidence of the thing in question, ways in which we bring out the possibilities or virtualities of mathematical things. Proofs are valuable not because they bring us assurance that the theorem is in fact true, but because they show the power of the theorem: how the theorem can present itself and hence what it can be.

Evidencing could not occur, of course, except "between" the mathematical object and the mathematician as its dative of presentation, and yet it would be quite incorrect to see evidence as "just" psychological. Rota correctly observes that the depsychologizing of evidence is one of the great achievements of phenomenology. To appeal to terminology used in another philosophical tradition, evidence is the introduction of a fact into the space of reasons, into the domain of logical involvements. Does not such an introduction belong to the space into which it enters? Is not evidence a rational act, indeed, the rational act of the highest order? What is given in evidence is just as logical and rigorous as what is derived within logical space. Mathematical facts are objective but they are achieved and even "owned" by someone in a sense of ownership that is sometimes recognized by adding a person's name to a theorem or conjecture. Rolle's theorem is so named not because of a psychological event but because of an intellectual display, an evidence, a logical event, that took place for someone at a certain time. Once having occurred to him, it can occur again to others at other places and times, and the theorem can be owned by them as well. Intellectual property is not lost when it is given away. Furthermore, we have to be prepared and disposed to let mathematical evidences occur to us: we must live the life of mathematics if we are to see mathematical things.

I think that one of the most valuable moves in this book is Rota's identification of evidence and the Kantian synthetic *a priori*. He observes that "all understanding is synthetic a priori; there is not and there cannot be any other kind." When we achieve evidence, we see something we had not seen before (hence, synthetic), and yet we see that it is necessary, that it could not have been otherwise (hence, *a priori*). Rota's observation sheds light on Kant's theory of judgment, on Husserl's concept of evidence, and on the nature of human understanding.

Another theme developed by Rota is that of "Fundierung." He shows that throughout our experience we encounter things that exist only as founded upon other things: a checkmate is founded upon moving certain pieces of chess, which in turn are founded upon certain pieces of wood or plastic. An insult is founded upon certain words being spoken, an act of generosity is founded upon something's being handed over. In perception, for example, the evidence that occurs to us goes beyond the physical impact on our sensory organs even though it is founded upon it; what we see is far more than meets the eye. Rota gives striking examples to bring out this relationship of founding, which he takes as a logical relationship, containing all the force of logical necessity. His point is strongly antireductionist. Reductionism is the inclination to see as "real" only the foundation, the substrate of things (the piece of wood in chess, the physical exchange in a social phenomenon, and especially the brain as founding the mind) and to deny the true existence of that which is founded. Rota's arguments against reductionism, along with his colorful examples, are a marvelous philosophical therapy for the debilitating illness of reductionism that so pervades our culture and our educational systems, leading us to deny things we all know to be true, such as the reality of choice, of intelligence, of emotive insight, and spiritual understanding. He shows that ontological reductionism and the prejudice for axiomatic systems are both escapes from reality, attempts to substitute something automatic, manageable, and packaged, something coercive, in place of the human situation, which we all acknowledge by the way we live, even as we deny it in our theories.

Rota calls for a widened mathematics that will incorporate such phenomena as evidence and "Fundierung," as well as anticipation, identification, concealment, surprise, and other forms of presentation that operate in our experience and thinking but have not been given an appropriate logical symbolism and articulation. Such phenomena have either not been recognized at all, or they have been relegated to the merely psychological. What has been formalized in logic and mathematics so far have been grammatical operators. It is an exciting and stimulating suggestion to say that various forms of presentation might also be formalized. Rota makes his proposal for a new mathematics in his treatment of artificial intelligence and computer science. These fields, which try to work with intelligent operations wider than those of standard formal logic, have shown, by their failures as well as by their partial successes, that a much richer and more flexible notion of logic is called for. The logic Rota anticipates will not displace the rational animal, the dative of manifestation, but it will bring the power of formalization and mathematics to areas scarcely recognized until now.

Rota's fascinating and sympathetic sketches of persons and places in twentieth-century mathematics should also be seen as part of his study of the correlation between mathematical truth and mathematicians. He sheds light on mathematics by showing the human setting in which it arises. His exhortations to mathematicians to become involved in the service of other disciplines is another point in his recognition of the human face of mathematics. He calls for a presentation of mathematics that uses intuitive, illuminating examples, and for texts with "a discursive, example-rich flow," as opposed to the rigid style that turns the reader into a "code-cracker." The imaginative example is essential to the achievement of mathematical evidence.

Rota makes use of other authors, but never as a mere commentator. He uses authors the way they would most want to be used, as vehicles for getting to the issues themselves. He is like a musician who listens to Mozart and then writes his own music himself. His instinct for mathematical evidence has made him especially alert to philosophical truth. Mathematics and philosophy were blended, after all, in some of the very first philosophers, the Pythagoreans. Their thinking, along with that of all the presocratics, was given a human twist by Socrates, who turned from nature to the human things. Gian-Carlo Rota makes an analogous turn, complementing objective mathematics by showing how it is a human achievement, an intelligent action accomplished by men. His writings have much of Socrates' irony and wit, and the occasional barb is also socratic, meant to illuminate and to sting the reader into looking at things afresh. In these essays, mathematics is restored to its context in being and in human life.

Introduction

Gian-Carlo Rota

The truth offends. In all languages of the world one finds proverbs that stress this truism in many colorful versions (*"veritas odium parit"* in Latin). More precisely: *certain* truths offend. Which truths offend? When and why do we "take offense?"

All cultures have offered variants of one and the same answer to these questions. We take offense at those truths that threaten any of the myths we profess to believe in. Taking offense is an effective way we have of shutting off some unpleasant truth. It works. It enables us to restore a hold on our dearest myths, to last until the next offending truth comes along.

Myths come in two kinds: working myths and wilting myths. Working myths are the bedrock of civilization, they are what college students in the sixties used to call "ultimate reality." We could not function without the solid support that we get from our working myths. We are not aware of our working myths.

Sooner or later, every working myth begins to wilt. We can tell that a myth is wilting as soon as we are able to express it in words. It then turns into a belief, to be preserved and defended.

A wilting myth is an albatross hanging from our necks. Only on rare occasions do we summon the courage to discard a wilting myth; more often, we hang on to a wilting myth to the very end. If anyone dares question any of our wilting myths, we will lash out and label him "elitist," "subversive," "reactionary," "irrational," "cynical," "nihilistic," "obscurantist." We will seize on some incorrect but irrelevant detail as an excuse to dismiss an entire argument. Most discussions, whether in science, in philosophy, in politics or in everyday conversation, are thinly veiled attacks or defenses of some wilting myth.

Eventually, a wilting myth gets dropped by all but the hard-liners.

These are the bigots, the fanatics, the mass murderers. Hitler staged a last-ditch defense of the cloying romantic myths of the past century. Stalin battled for the dying myth of socialism. The kooks of Montana are taking the last stand in defense of the myth of the West.

The wilting myths of the millenium are the theme of this book. Never before in history have so many myths begun to wilt at the same time, and a hard choice had to be made, to wit:

1. *The myth of monolithic personality* "Every scientist must also be a good guy." "If you are good at math, then you will be good at anything." "Great men are great in everything they do." "Heidegger cannot be a good philosopher because he was a Nazi."

Against this myth, sketches of the lives of some notable mathematicians of this century are given in "Fine Hall in the Golden Age," "Light Shadows," "The Story of a Ménage à Trois" and "The Lost Café." When first published, each of these chapters caused a stir of sorts. After reading the section "Problem Solvers and Theorizers," a mathematician friend (one of the most distinguished living mathematicians) wrote that he would not speak to the author ever again. Another mathematician threatened a lawsuit after reading the section on Emil Artin in "Fine Hall in the Golden Age." After publication of a heavily edited version of "The Lost Café" in the magazine *Los Alamos Science*, the author was permanently excluded from the older echelons of Los Alamos society.

2. *The myth of reductionism* "The workings of the mind can be reduced to the brain." "The universe is nothing but a psi function." "Biology is a branch of physics." "Everything has a mechanical explanation."

Critiques of these frequently heard assertions are found in "The Barrier of Meaning," "*Fundierung* as a Logical Concept," "The Primacy of Identity," "The Barber of Seville, or the Useless Precaution," and "Three Senses of 'A is B' in Heidegger." The confusion between scientific thought and reductionist error is rampant in our day, and critiques of reductionism are mistakenly viewed as attacks on the scientific method.

Reductionism would do away with the autonomy of biology and physics, of physics and mathematics, as well as with the autonomy of science and philosophy. "The Pernicious Influence of Mathematics upon Philosophy" is motivated by the loss of autonomy in philosophy. The paper (reprinted five times in four languages) was taken as a personal insult by several living philosophers.

3. *The zero-one myth*. "If a marble is not white, it must be black." "If you don't believe that everything can be explained in terms of atoms and molecules, you must be an irrationalist." "There is no valid explanation other than causal explanation."

The ideal of rationality of the Age of Enlightenment is too narrow, and we need not abandon all reason when we stray from this seventeenth-century straitjacket. Already the life sciences follow a logic that is a long way from the logic of mechanics and causal explanation.

The simplistic cravings for a "nothing but" are dealt with in "The Phenomenology of Mathematical Truth," "The Phenomenology of Mathematical Beauty" and "The Phenomenology of Mathematical Proof." There is no answer to the question "What is mathematics?" because the word "is" is misused in such a question. A distintuished mathematician, who is also one of the last hard-line Stalinists, criticized these essays for their "anarchy." He is right.

The book concludes with a selection of book reviews the author has published in the last twenty-five years. It was hard to resist the temptation to publish samples of the hate mail that was received after these reviews. The truth offends.

The author thanks the editor, Fabrizio Palombi, who organized the text and supplied an ample bibliography, and most of all Ann Kostant of Birkhäuser Boston, without whose help this book would never have seen the light of day.

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Finally, the author thanks the Sloan Foundation, whose generous grant led to the writing of these essays.

Cambridge, MA, September 1, 1996.

Indiscrete Thoughts

PART I

Persons and Places

CHAPTER I

Fine Hall in its Golden Age

Princeton in the Early Fifties

OUR FAITH IN MATHEMATICS is not likely to wane if we openly acknowledge that the personalities of even the greatest mathematicians may be as flawed as those of anyone else. The greater a mathematician, the more important it is to bring out the contradictions in his or her personality. Psychologists of the future, if they should ever read such accounts, may better succeed in explaining what we, blinded by prejudice, would rather not face up to.

The biographer who frankly admits his bias is, in my opinion, more honest than the one who, appealing to objectivity, conceals his bias in the selection of facts to be told. Rather than attempting to be objective, I have chosen to transcribe as faithfully as I can the inextricable twine of fact, opinion and idealization that I have found in my memories of what happened forty-five years ago. I hope thereby to have told the truth. Every sentence I have written should be prefixed by "It is my opinion that..."

I apologize to those readers who may find themselves rudely deprived of the comforts of myth.

Alonzo Church

It cannot be a complete coincidence that several outstanding logicians of the twentieth century found shelter in asylums at some time in their lives: Cantor, Zermelo, Gödel, Peano, and Post are some. Alonzo Church was one of the saner among them, though in some ways his behavior must be classified as strange, even by mathematicians' standards.

He looked like a cross between a panda and a large owl. He spoke softly in complete paragraphs which seemed to have been read out of a book, evenly and slowly enunciated, as by a talking machine. When interrupted, he would pause for an uncomfortably long period to recover the thread of the argument. He never made casual remarks: they did not belong in the baggage of formal logic. For example, he would not say, "It is raining." Such a statement, taken in isolation, makes no sense. (Whether it is actually raining or not does not matter; what matters is consistence). He would say instead, "I must postpone my departure for Nassau Street, inasmuch as it is raining, a fact which I can verify by looking out the window." (These were not his exact words). Gilbert Ryle has criticized philosophers for testing their theories of language with examples which are never used in ordinary speech. Church's discourse was precisely one such example.

He had unusual working habits. He could be seen in a corridor in Fine Hall at any time of day or night, rather like the Phantom of the Opera. Once, on Christmas day, I decided to go to the Fine Hall library (which was always open) to look up something. I met Church on the stairs. He greeted me without surprise.

He owned a sizable collection of science-fiction novels, most of which looked well thumbed. Each volume was mysteriously marked either with a circle or with a cross. Corrections to wrong page numberings in the table of contents had been penciled into several volumes.

His one year course in mathematical logic was one of Princeton University's great offerings. It attracted as many as four students in 1951 (none of them were philosophy students, it must be added, to philosophy's discredit). Every lecture began with a ten-minute ceremony of erasing the blackboard until it was absolutely spotless. We tried to save him the effort by erasing the board before his arrival, but to no avail. The ritual could not be disposed of; often it required water, soap, and brush, and was followed by another ten minutes of total silence while the blackboard was drying. Perhaps he was preparing the lecture while erasing; I don't think so. His lectures hardly needed any preparation. They were a literal repetition of the typewritten text he had written over a period of twenty years, a copy of which was to be found upstairs in the Fine Hall library. (The manuscript's pages had yellowed with the years, and smelled foul. Church's definitive treatise was not published for another five years).[1] Occasionally, one of the sentences spoken in class would be at variance with the text upstairs, and he would warn us in advance of the discrepancy between oral and written presentation. For greater precision, everything he said (except some fascinating side excursions which he invariably prefixed by a sentence like, "I will now interrupt and make a meta-mathematical [sic] remark") was carefully written down on the blackboard, in large English-style handwriting, like that of a grade-school teacher, complete with punctuation and paragraphs. Occasionally, he carelessly skipped a letter in a word. At first we pointed out these oversights, but we quickly learned that they would create a slight panic, so we kept our mouths shut. Once he had to use a variant of a previously proved theorem, which differed only by a change of notation. After a moment of silence, he turned to the class and said, "I could simply say 'likewise,' but I'd better prove it again."

It may be asked why anyone would bother to sit in a lecture which was the literal repetition of an available text. Such a question would betray an oversimplified view of what goes on in a classroom. What one really learns in class is what one does not know at the time one is learning. The person lecturing to us was logic incarnate. His pauses, hesitations, emphases, his betrayals of emotion (however rare) and sundry other nonverbal phenomena taught us a lot more logic than any written text could. We learned to think in unison with him as he spoke, as if following the demonstration of a calisthenics instructor. Church's course permanently improved the rigor of our reasoning.

The course began with the axioms for the propositional calculus (those of Russell and Whitehead's *Principia Mathematica*,[2] I believe) that take material implication as the only primitive connective. The exercises at the end of the first chapter were mere translations of some identities of naive set theory in terms of material implication. It took me a tremendous effort to prove them, since I was unaware of the fact that one could start with an equivalent set of axioms using "and" and "or" (where the disjunctive normal form provides automatic proofs) and then translate each proof step by step in terms of implication. I went to see Church to discuss my difficulties, and far from giving away the easy solution, he spent hours with me devising direct proofs using implication only. Toward the end of the course I brought to him the sheaf of papers containing the solutions to the problems (all problems he assigned were optional, since they could not logically be made to fit into the formal text). He looked at them as if expecting them, and then pulled out of his drawer a note he had just published in *Portugaliae Mathematica*,[3] where similar problems were posed for "conditional disjunction," a ternary connective he had introduced. Now that I was properly trained, he wanted me to repeat the work with conditional disjunction as the primitive connective. His graduate students had declined a similar request, no doubt because they considered it to be beneath them.

Mathematical logic has not been held in high regard at Princeton, then or now. Two minutes before the end of Church's lecture (the course met in the largest classroom in Fine Hall), Lefschetz would begin to peek through the door. He glared at me and the spotless text on the blackboard; sometimes he shook his head to make it clear that he considered me a lost cause. The following class was taught by Kodaira, at that time a recent arrival from Japan, whose work in geometry was revered by everyone in the Princeton main line. The classroom was packed during Kodaira's lecture. Even though his English was atrocious, his lectures were crystal clear. (Among other things, he stuttered. Because of deep-seated prejudices of some of its members, the mathematics department refused to appoint him full-time to the Princeton faculty).

I was too young and too shy to have an opinion of my own about Church and mathematical logic. I was in love with the subject, and his course was my first graduate course. I sensed disapproval all around me; only Roger Lyndon (the inventor of spectral sequences), who had been my freshman advisor, encouraged me. Shortly afterward he himself was encouraged to move to Michigan. Fortunately, I had met one of Church's most flamboyant former students, John Kemeny, who, having just finished his term as a mathematics instructor, was being eased — by Lefschetz's gentle hand — into the philosophy department. (The following year he left for Dartmouth, where he eventually became president).

Kemeny's seminar in the philosophy of science (which that year attracted as many as six students, a record) was refreshing training in basic reasoning. Kemeny was not afraid to appear pedestrian, trivial, or stupid; what mattered was to respect the facts, to draw distinctions even when they clashed with our prejudices, and to avoid black-and-white oversimplifications. Mathematicians have always found Kemeny's common sense revolting.

"There is no reason why a great mathematician should not also be a great bigot," he once said on concluding a discussion whose beginning I have by now forgotten. "Look at your teachers in Fine Hall, at how they treat one of the greatest living mathematicians, Alonzo Church."

I left literally speechless. What? These demi-gods of Fine Hall were not perfect beings? I had learned from Kemeny a basic lesson: a good mathematician is not necessarily a "nice guy."

William Feller

His name was neither William nor Feller. He was named Willibold by his Catholic mother in Croatia, after his birthday saint; his original last name was a Slavic tongue twister, which he changed while still a student at Göttingen (probably on a suggestion of his teacher, Courant). He did not like to be reminded of his Balkan origins, and I had the impression that in America he wanted to be taken for a German who had Anglicized his name. From the time he moved from Cornell to Princeton in 1950, his whole life revolved around a feeling of inferiority. He secretly considered himself to be one of the lowest ranking members of the Princeton mathematics department, probably the second lowest after the colleague who had brought him there, with whom he had promptly quarreled after arriving in Princeton.

In retrospect, nothing could be farther from the truth. Feller's treatise in probability is one of the great masterpieces of mathematics of all time.[4] It has survived unscathed the onslaughts of successive waves of rewriting, and it is still secretly read by every probabilist, many of whom refuse to admit that they still constantly consult it and refer to it as "trivial" (like high school students complaining that Shakespeare's plays are full of platitudes). For a long time, Feller's treatise was the mathematics book most quoted by nonmathematicians.

But Feller would never have admitted to his success. He was one of the first generation who thought probabilistically (the others: Doob, Kac, Lévy, and Kolmogorov), but when it came to writing down any of his results for publication, he would chicken out and recast the mathematics in purely analytic terms. It took one more generation of mathematicians, the generation of Harris, McKean, Ray, Kesten, Spitzer, before probability came to be written the way it is practiced.

His lectures were loud and entertaining. He wrote very large on the blackboard, in a beautiful Italianate handwriting with lots of whirls. Sometimes only one huge formula appeared on the blackboard during the entire period; the rest was handwaving. His proofs — insofar as one can speak of proofs — were often deficient. Nonetheless, they were convincing, and the results became unforgettably clear after he had explained them. The main idea was never wrong.

He took umbrage when someone interrupted his lecturing by pointing out some glaring mistake. He became red in the face and raised his voice, often to full shouting range. It was reported that on