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Reminiscences of Chicago in the Fifties

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I came to the Chicago Math Department for graduate study in 1952 after two years of undergraduate study at Saint Lawrence University in upper New York State. I knew practically no mathematics, but a knowledge of mathematics did not seem to be a prerequisite! The University required only that I pass a special exam on general knowledge and intellectual ability.

Although Robert Hutchins had left a couple years earlier, Chicago was still under his influence. Hutchins' pathbreaking, iconoclastic ideas about education were in full force: to study original works ("great books"); that the purpose of university study is to develop the student's ability to think critically rather than to prepare the student for a profession; emphasis on intense class discussion, but grades based only on written examinations; the firm belief that much of high school is a waste of time; and downgrading of intercollegiate athletics (there was no football team). Hutchins' program created the most exciting intellectual atmosphere I've ever seen in a University. While his ideas probably had little effect on graduate math courses, they attracted first rate scholars, scientists, writers, and artists.

Hutchins strongly encouraged students to come to Chicago after only two years of high school; and this program was still in full swing. But while many undergraduates were very young, most students were in graduate school; and many students were veterans of World War II or the Korean War.

Besides academics, the Hyde Park community attracted writers, actors, and musicians of all kinds, as well as assorted crazies and weirdoes. Many graduates and dropouts from the University stayed in the community for years. As a result, Hyde Park contained a rich mixture of interesting people; and the intellectual and cultural environment was extraordinarily fertile and exciting.

The campus was not as isolated from the surrounding community as it is now; there were more bookstores, bars, restaurants, and coffee houses than there are now, and more cheap apartments. The streets were not as dangerous, although this changed for the worse during my six years as a student.

The University took its then traditional role *in loco parentis* very lightly; students were not required to live in dormitories; and warnings were posted in dormitories the day before bed-checks were made.

There was a great deal of folk music and jazz in Chicago. There was probably rock and roll too, but at the University of Chicago we (at least the people I knew) certainly would not listen to anything so lowbrow. I

played for dances at the dormitory in a jazz band which included bassist William Dement, now a leading researcher on sleep and dreams, a young instructor named Homer Goldberg whom I've lost track of, myself on piano, and others I've forgotten.

A group of us founded the University of Chicago Folklore Society, sponsoring square dances, hootentannies, and concerts with Pete Seeger, Peggy Seeger, Big Bill Broonzy, Sonny Terry, Odetta, and others. The University Administration was worried about Pete Seeger, since he was under investigation by the Committee on Unamerican Activities of the House of Representatives. But he was allowed to sing on the campus.

Paul Robeson, the famous black actor, singer, and Communist, who was not allowed to leave the country, also gave a concert on the campus. That night many FBI agents improved their musical knowledge.

Every year a local cooperative school held a fundraising jazz concert; the master of ceremonies was the semanticist S.I. Hayakawa (later President of San Francisco State College, and then Senator from California). I remember well a talk he gave at one of the concerts, in which he contrasted the earthy, realistic lyrics of folk blues with the self-pitying themes of the "kick me in the face because I love you school of popular songs, which Mr. Clancy Hayes will now illustrate with a song he wrote." Clancy did fine.

There were at least three theatre groups near the campus, all excellent. I spend the summer of 1954 working with the Compass Theatre, the forerun-

Moe Hirsch, 1954

Irving Segal, 1950

ner of Second City and many other improvisational groups, along with Mike Nichols, Elaine May, Barbara Harris, and other unknown actors. Nichols was an announcer on radio station WFMT, and for years ran a marvelous folk music program called "The Midnight Special" on which my friends and I occasionally played.

I roomed with five other graduate students in an amazingly cheap and dirty apartment at 5546 Ingleside Avenue called the GDI, which stood for "The God Damned Independents." Originally started by veterans in the late forties, it continued as an informal cooperative until about 1955. Two of my housemates, Ed Silverstein and Jerry Friedman, were physics graduate students. They invited me to the Physics Department's annual picnic where Enrico Fermi played fascinatedly with a yoyo. Jerry was recently awarded a Nobel Prize. I remember his telling us gleefully, upon getting his doctorate, that his first grade teacher had wanted to put him in a special class for the mentally retarded.

Ed and I liked to amuse our housemates by playing tricks on them. Every night for a week the two of us gambled in the kitchen, playing a flashy card game called "Scan," in which large sums of money rapidly changed hands. One evening when Ed thought I was winning too much he put the king and queen of spades on the table and cried "Grand Nullo!," sweeping all the cards and money to his side of the table. Our housemates were astounded,

Saunders Mac Lane, 1950

especially when I told them (truly) it was the first time I had ever seen a Grand Nullo. They became very interested in watching the action, and we tried to explain the game to them, urging them to play. But we didn't tell them that in fact there was no such game: we just made up the rules as we went along. When finally we admitted that the game was just a joke, our housemate Arthur was terribly disappointed to hear that the game wasn't real: "I was just beginning to catch on," he complained. He was a brilliant chemistry student, but strange in some ways.

It is perhaps obvious that I found plenty of activities more exciting than attending classes. My grades in the first two years, were, I regret to say, atrocious; I even managed to fail Marshall Stone's course in measure theory (it didn't help that the textbook was in French). Not only did I find extracurricular activities more interesting than classes, but for some reason many of my first classes were assigned to some of the worst lecturers in the department. They were either just about to retire, or else they were fresh Ph.D.s; but none of them was able to inspire me to study.

Honorable exceptions included Irving Segal's course in set theory (even though he never prepared or remembered the proofs of the equivalence of 12 forms of the Axiom of Choice); Shiing-Shen Chern's course in differential geometry; Paul Halmos's course in metric spaces, and Ed Spanier's course in topology. For the first time mathematics became not only interesting but exciting and challenging. I was inspired enough to study seriously for

the Master's Exam, managing to pass it at a high enough level that I was permitted, if not encouraged, to continue in the Ph.D. program. At least one student who was asked to leave refused to do so, and today is quite eminent.

After I got serious about mathematics, I discovered there were some wonderful teachers on the faculty. I took inspiring topology courses with Ed Spanier, who later directed my doctoral work. His exceptionally clear and well-organized lectures perhaps were the reason I developed an early love for the subject. I took as many courses as I could with Spanier, including Topological Groups and Calculus of Variations in the Large.

I also made a point of taking all courses offered by Halmos. I even audited an undergraduate course he gave on (of all things) complex variables. One of my favorite memories is his reply when a student asked him how to compute a certain line integral. Halmos wrote it down, stared at it for not more than two seconds, and said firmly, "I never integrate in public!" A very useful remark. Halmos also taught me "topological algebra," which was functional analysis; and a version of mathematical logic.

Halmos was not only an inspired lecturer, he wrote some of the finest textbooks I've ever seen. Several generations of students have learned linear algebra from his "Finite Dimensional Vector Spaces" and measure theory from his "Measure Theory," two of his books that I learned a lot from.

From Kaplansky I learned field theory. I remember complaining to fellow student Eben Matlis that despite Kap's fine lectures (which all seemed to begin mysteriously with "Consider the following obvious identity"), I disliked the subject because there was nothing I could visualize. "But that's exactly why I like it" was the reply, "I can never understand those pictures the geometers are always drawing!" Kap also taught an interesting course in differential Galois theory. But one of the best courses was one he gave on homology theory, despite (or more likely, because of) the fact that it was far from his own research.

Stone taught a course — rather beyond me — on spectral theory, which began with Hilbert spaces over the quaternions, and ended with recent research that was completely over my head. His handwriting was terrible, but that didn't matter because he stood directly in front of what he wrote, spoke to it, and immediately erased it.

There is not enough space to review, or even list, all the first-rate courses I had. These included Chern's differential geometry, whose modern treatment of tensors fields I didn't properly appreciate until I taught the subject myself; O.F.G. Schilling's proseminar, which required students to learn advanced material on their own; Lashof's course on Lie groups. (When Schilling lent a student a book, as he often did, he always gave the firm instruction, "Please don't wrap herring in it!") From Saunders Mac Lane I remember inspiring seminars on fiber spaces and Eilenberg-MacLane spaces, which he modestly called " $K(\pi, n)$ spaces."

A remarkable number of the math students at Chicago in the fifties went on to become fine mathematicians. Some that I recall are: Hy Bass, Paul Cohen, Jerry Spanier, Larry Wos, Joe Wolf, Joshua Leslie, Robert Bonic, John Thompson, Steve Schanuel, Ed Posner, Harold Levine, Eben Matlis, Elon Lima, Guido Weiss, Ray Kunze, Woody Stinespring, Lester Dubins, Don Ornstein, Lennie Gross (one of my housemates), Arshag Hajian, Larry Glasser, Eli Stein, Anil Chowdury (now Nerode), Jack Feldman, Harold Widom — and there were many others. My colleague Rob Kirby came just after I left.

Mac Lane organized the annual Math Department beer parties, which were very jolly affairs. The students wrote skits and songs poking fun at the faculty, using what we considered ingenious puns like “Professor Sixpence” (for Schilling) and “Dr. Gropingduck” (for Grothendieck). One of the songs, I forget by whom, was to the tune of an official University anthem. I record it here for posterity:

‘C’ stands for C-star Algebra,
 ‘H’ stands for Hilbert Space,
 ‘I’ stands for Integration,
 A course that we cannot face;
 ‘C’ stands for Category,
 ‘A’ for Associative Law;
 Gee, but we’re weary, of Galois Theory!
 O Orthonormal, Oh we’re conformal,
 Oh what a school we’re in!

Another deathless ditty, which I helped write, goes to the tune of “Glory, Glory Hallelujah”:

The Ballad of Bourbaki

Analysts, topologists, geometers agree,
 When it comes to generality there’s none like Bourbaki;
 One theorem by them will cover N by you or me,
 Bourbaki goes marching on!

Chorus:

Glory, glory hallelujah!
 Their generality will fool ya,
 They’re axiomatically peculiar,
 Bourbaki goes marching on!

To prove that two plus two is four, here is what they do:
 They prove that a plus b is c when a and b are two;
 We know that c is half of d , and d is four times two—
 Bourbaki goes marching on!
 (Repeat chorus *ad nauseam*.)

After having imbibed sufficiently, Mac Lane would boom out his spirited rendition of "My name is Samuel Hall," with everyone joining on the refrain "Damn your eyes!"

Those parties were typical of a spirit of warm camaraderie in the math department at Chicago, which I have not experienced elsewhere. In my thirty years at Berkeley, for example, I remember only one skit performed at a Math Department party; and it was written not by the students but by a visiting lecturer (Mark Green). Very few faculty members show up at departmental picnics, or even the afternoon coffee hours.

The department was a relatively small place then, which may be part of the reason for the feeling of unity. In fact mathematics as a whole was a smaller community, much more isolated than it is today. You had to be a little crazy to go into mathematics. Now many more students go into math and science, and there are many more industrial and government jobs open to mathematicians. It is more like any other profession. I believe this is all to the good, but it also means that mathematicians no longer tend to see themselves as a very special community.

The song about Bourbaki brings up the fact that its (their? — Bourbaki's) grip on the department was absolute. It is very easy to describe the applied mathematics I was exposed to: None. The words were never uttered. Functional analysis was taught without mentioning differential equations. In Zygmund's course on differential equations we were exposed to the "heat equation," the "wave equation," and so forth, but I don't recall being taught their derivations from physical principles — they were just quaint names. Complex function theory was taught without benefit of the intuition available from electrical current flow, which I now think of as analogous to teaching calculus without mentioning velocity. Although there was a Committee on Mathematical Biology on the campus, I didn't learn of its existence until much later. Certainly I never heard a colloquium talk about any applied subject.

The extreme emphasis on abstract structure reflected the spirit of the times; no doubt similar conditions obtained at Princeton, Harvard, and elsewhere. And applications of mathematics in the fifties were not nearly as developed as in they are in the nineties: For example, there was no such thing as software; complexity theory didn't exist; differential equations theory was computational and *ad hoc*; there were no such things as "chaos" or "fractals." Still, we could have been offered cybernetics, probability, and information theory, or even classical mechanics. In fact Halmos, a few years ahead of his time, wrote the first book (at least in English) on Ergodic Theory.

This is not a criticism of Chicago; rather it is a critique of the dominant spirit in American academic mathematics in the fifties. In retrospect, however, I feel that I missed what should have been an important part of my education.

Halmos has different ideas about the value of Pure vs. Applied Math-

ematics, stated plainly by the title of his controversial article (in *Mathematics Tomorrow*, Lynn Steen ed.), "Applied Mathematics is Bad Mathematics." It is ironic that the first example he gives of mathematics that is "discrete, finite, pure," is the problem of tiling a square by distinct squares. The main tool in its solution are equations coming from Kirchhoff's laws of electrical circuits — applied math *par excellence*!

An important educational role was played by the many visitors passing through Eckhart Hall in the fifties. Perhaps they were temporary lecturers, or even merely colloquium speakers, but I vividly remember lectures, courses, and seminars by Armand Borel, Richard Palais, Christopher Zeeman, Bruce Reinhart, Robert Hermann, Serge Lang, Eldon Dyer, René Thom, Norman Steenrod, R.H. Bing, and many others.

Bing, Wallace, and Pitcher, 1955

I remember vividly a colloquium by Bing. Growing up in New York I had met very few southerners, and had unconsciously absorbed the common New York prejudice that they were ignorant rednecks. It shocked me to hear sophisticated mathematics expounded in a strong Texas drawl.

Bing was a bit of a joker. His talk dealt with embeddings in three-space of Cartesian products of a surface and an interval (showing that one of the surfaces must be tame). In the question period Thom asked, in his heavy French accent, if this could be generalized to fibrations (a fibration is a generalized product). Bing pretended to misunderstand him: "I don't know what you mean by *vibrations*" he replied, "this theorem has nothing

to do with *vibrations*!” I have no doubt that R.H. knew very well what Thom meant.

At another colloquium a Japanese mathematician gave an interesting talk about the development of mathematics in Japan. He said its slow development was due to the jealousy and secrecy of competing schools. Students had to take an oath in blood not to reveal what they learned to outsiders. From the audience André Weil remarked, “I think that’s a very good idea.”

Weil ran an elite seminar much too advanced to me. I didn’t have any course from him, nor can I remember ever speaking with him at Chicago.

When I was a post-doc at the Institute (that is, the Institute for Advanced Study, still *the* institute to me), I submitted my doctoral thesis to the *Annals of Mathematics*, of which he was editor. He riffled the pages a few times, found it wanting, and handed it back to me with the words: “We don’t publish doctoral theses unless they solve the Riemann Hypothesis.” I don’t think that was strictly true, but at least I didn’t have to wait six months for a rejection.

In Princeton Weil ran a current research seminar, which I did attend. At the organizing meeting he assigned topics and dates to all the speakers. When a young mathematician from Japan, assigned to speak in a few weeks, protested that his English was very bad, Weil told him firmly, “By November 15 you will learn English.” And he did.

In order to earn some money I taught elementary mathematics at night at Illinois Institute of Technology. By and large these students were neither interested in nor prepared for further study in mathematics, but for various reasons needed another course — not the subject, just a record of passing the course. I have never forgotten one student who insisted on simplifying $(a + b)/a$ into b , explaining that he did this by “canceling” the a ’s. When I showed him with several examples that this gives the wrong answer, he looked puzzled, and asked me, “Yes, I see that it’s not true in those particular examples, but why isn’t it true *in general*?” For 35 years I have been unable to think of a suitable reply. Probably Halmos would have known what to say.

Nathan Reingold was chair of the Math Department at IIT. He generously told us teachers, “I don’t care whom you pass, but save the A’s and B’s for the good students,” so my canceling student passed. Reingold used to consult on the side. He told me he once was offered a job to compute some very strange probabilities. When he asked what they were for, he was told they applied to gambling equipment. He was worried about accepting the job, since gambling was illegal, but was assured that in Chicago it was not against the law to manufacture or sell gambling equipment, only to use it. He was not told who bought the equipment.

The person who most strongly influenced my mathematical career was Steve Smale, who came to Chicago in 1956 directly after his Michigan Ph.D. (he was Raoul Bott’s first student). I met him in Mexico City at the Sympo-

sium on Algebraic Topology; his work in the topology of smooth manifolds was one of the few things there I could understand. Back at Chicago I would go to his office every day to explain my much simpler proof of his result; and every day he would patiently explain why I didn't have a proof. Eventually he taught me to understand his work, which dealt with the then unnamed field of Differential Topology. With the help of his inspiring geometrical intuition, and Spanier's masterful teaching of algebraic topology, I eventually wrote a thesis.

By an amazing coincidence, Chern, Spanier, and Smale left Chicago forever and came to Berkeley at the same time I did. This was a stroke of good fortune for me, but it must have been a severe shock for Chicago.

While Chicago has continued its tradition of the highest mathematical excellence, I shall always look back on my experience in Eckhart Hall during the fifties as a wondrous Golden Age.

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