John G. Kemeny: Computing Pioneer

Lynn Arthur Steen

John G. Kemeny, co-author of Basic and co-developer of the Dartmouth Time-Sharing System, returned to full-time teaching in June 1982 after completing 11 years as President of Dartmouth College.

In 1979 he was selected by President Jimmy Carter to chair the Presidential Commission to investigate the Three Mile Island Accident. The commission's report, submitted in October 1979, was highly critical of the nuclear power industry and its federal regulators.

A member of the Dartmouth faculty since 1953, John Kemeny was inaugurated thirteenth president on March 1, 1970, at the age of 43. He served as chairman of Dartmouth's Department of Mathematics from 1955 to 1967, building it into one nationally recognized for leadership in both undergraduate and graduate instruction. Deeply committed to teaching, John Kemeny continued during his term as president to teach two courses each year.

As President of Dartmouth, John Kemeny moved the all-male institution to coed status; renewed the College's founding commitment to educating significant numbers of Indian Americans; began the Dartmouth Plan for year-round operation; and initiated a program of continuing education in liberal studies for business and professional people known as the Dartmouth Institute.

As chairman of mathematics at Dartmouth, John Kemeny helped guide Dartmouth to national leadership in educational uses of computing. He also introduced finite mathematics as an important alternative to calculus for students in the social sciences.

A native of Budapest, Hungary, John Kemeny came to the United States in 1940. During World War II, while still in his teens, he interrupted his undergraduate study at Princeton to work on the Manhattan Project in Los Alamos, N. M. Later, as a graduate student at Princeton, he served as research assistant to Albert Einstein. He received both his bachelor's and doctor's degrees from Princeton, both in logic.

In June 1982 John Kemeny spoke at a conference sponsored by the Sloan Foundation at Williams College devoted to the relation between calculus and discrete mathematics in the first two years of the undergraduate curriculum. Following that conference, we interviewed him for TYCMJ in his Dartmouth office, just before the first of his two regular classes in Dartmouth's summer term.

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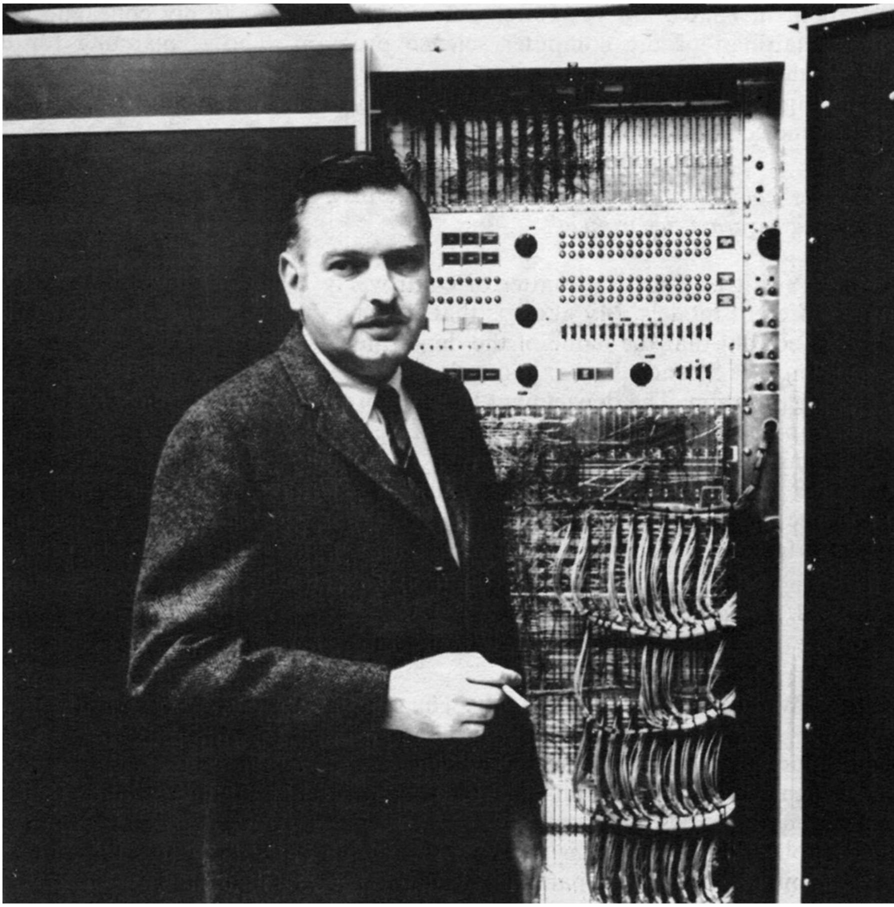
TYCMJ: *You are now returning to the classroom after* 11 *years as President of Dartmouth.*

Kemeny: Eleven and a third years, almost to the day.



The guts of one of the machines in Dartmouth's first large computer system.

TYCMJ: *Are there any special projects on your agenda? Are you going to write a book, or develop a new programming language?*

Kemeny: I am thinking of two different kinds of things, one having to do with teaching. At Dartmouth, although we do have a number of options, I think we have to work on our introductory mathematics sequences. I want to play a role in that, most particularly to bring computing more into the sequence. Eventually I'd like to do battle also on the kinds of things that the Sloan conference talked about, that science students shouldn't be introduced only to calculus. Those are my teaching priorities.

In research, although I did quite a bit of reading during my year off, I have not yet made up my mind where I will do my research. I probably will go back and do some work in probability theory, which is the last field I worked in before I became president. And I would like to get active in computer science. Although I enjoy talking about it, I have not yet gotten active in it. I talked to my colleague Steve Garland, chairman of the computer science program, who is planning for this coming academic year a seminar on computer science problems. I suspect that in the beginning I will be more a listener than an active participant, but I hope out of that will come some problems that interest me.

TYCMJ: *Is computer science at Dartmouth still a program within mathematics, rather than a separate department?*

Kemeny: Yes it is. That is a matter of controversy. The committee has come up with five different models. My guess is that the one that will carry is that in which we stay joined, but that the name of the department will be changed to Mathematics and Computer Science. This is more than just a symbolic change. It may mean certain reorganization. The department has a chairman and a vice-chairman and we may wind up having a chairman and two vice-chairmen, one for mathematics and one for computer science. It may be, for example, that on tenure decisions in mathematics the mathematics members will have more say-so, and that for computer science tenure the computer science members will have more say-so. It may be sort of a federalist system.

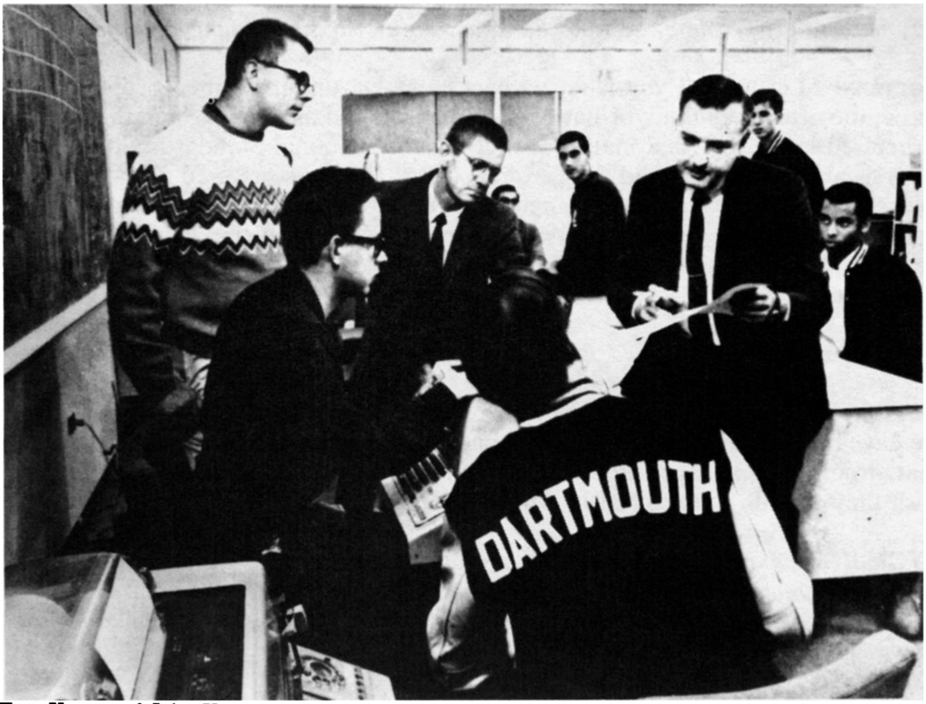
TYCMJ: *At big universities, of course, they tend to be separate departments and at small colleges they tend to be the same. Dartmouth is right in the middle.*

Kemeny: We are always in the middle. The overwhelming argument still is that if we split up, for the foreseeable future, computer science would be fairly weak. That's because some of their allies who help teach computer science would stay in the math department. I can't imagine, for example, either Don Kreider or myself leaving the mathematics department. An even bigger argument is that the best way to avoid duplication of courses is to stay within one department. Then you don't get into arguments as to which department teaches which courses.

TYCMJ: *Let me go back to twenty years ago when you were working on creating Basic and time-sharing. With hindsight we can see that this was a really revolutionary development, that has had a dramatic effect on computing. What were your thoughts when you were beginning it? Did you anticipate its effects?*

Kemeny: Let me give you a little bit of history on that. It is very important that Tom Kurtz should be mentioned in this connection, because he is a very modest person and I am not. I seem to have received 90% of the credit, when the effort was strictly 50-50. Actually the initiative was taken by Tom. We only had a small computer and he came to me when I was chairman of the math department and said, "Don't you think the time has come when all liberal arts students should know how to use the computer?" I said, "Sure, Tom, but there is no way on today's computers that we can teach 800 students." Tom said that he was thinking of a different kind of system, and he vaguely outlined what is now called time-sharing.

He won me over fairly fast, and we designed the first time-sharing system together. It was my idea then to say, while we are at it, can't we design a language better than Fortran? Remember this was the Fortran of 1963 which was a horror



Tom Kurtz and John Kemeny with a group of student assistants at their then new computing center.

compared to the Fortran of today. Tom said, "Yes, but what's the use of teaching a language to Dartmouth students that they will never be able to use anywhere else except at Dartmouth?" Tom was normally farsighted, but that was his famous incorrect prediction. He loves to tell about it, since, as you probably know, Basic is now the most widely used language in computers.

We did do both together. We both were absolutely convinced that the time would come when any intelligent person had to know how to use the computer. That does not mean that we foresaw everything that happened since then. I can best point to the year 1966 when we dedicated the building for the computer. Up to then it was in some horrible basement. On the dedication of the Kiewitt Computation Center, I gave the main speech in which I predicted what computers would be like 10 to 20 years later.

If one looks back at that speech, it has some remarkable farsightedness in it, and some major shortcomings. I did predict in that speech that within 25 years computers in the home would be as common as television sets were in 1966. And I predicted some of the things computers would be used for in the home, predictions that have turned out to be remarkably accurate. In 1966 everyone who heard me thought that I was just making up things.

Where I was totally wrong in my predictions was that I did not foresee the coming of microcomputers. All of my predictions were based on terminals being connected to a central system. I also did not foresee graphics—pictures then were terribly primitive. I sort of foresaw the software revolution, but underestimated dramatically the hardware advances.

TYCMJ: *Does it bother you at all now that computer science departments are trying very hard to get people away from Basic and to use structured languages like Pascal?*

Kemeny: Let me tell you what bothers us at Dartmouth. When people think of Basic, too often they think of Basic as it was in 1966. Basic at Dartmouth is a totally structured language. As a matter of fact the International Standards Committee in Basic is about to report and they are reporting a highly structured version of Basic. We all agree that structured languages are far superior. We haven't used the nonstructured Basic in many years at Dartmouth. The problem, however, is that the versions of Basic that are implemented on microcomputers tend to be the old Basic. Therefore people tend to think of Basic as it was ten years ago.

TYCMJ: *That [ten-year-old Basic] is what is being taught in the public schools.*

Kemeny: You are right. But we have all been won over to structured Basic, and we have had one at Dartmouth for six or seven years now. Look, I completely agree that structured languages are far superior and that is what should be taught. I just wish they wouldn't say that if it's structured, it's not Basic.

TYCMJ: *One of the really special things about computing is how active students are. They are creative, they take leadership roles, they really get involved. Why is computing so special? Why don't they do that in mathematics or in writing or in history?*

Kemeny: In the development of the original time-sharing system, it was not just Tom and myself—we were highly part-time. It was twelve undergraduate students, and believe me they worked incredible hours. We have endless stories which I won't go into; I'm sure you know similar stories of the number of hours students are willing to work at computing.

Equally important, computing attracts not just students who naturally drift towards mathematics. It is true that students inclined to mathematics are often good at computing—although not all of them are. But the converse is not true. There are large numbers of students who would never have come into math. I even know some who hated math but who fell in love with computing. In an article I have just drafted I tell a story of a woman religion major at Dartmouth who almost didn't graduate because she refused to take one more science course. She was a friend of my daughter, who persuaded her to take my introductory programming course almost over her dead body. Then she became a computer scientist—and a very good one. Of course that is an extreme case, of a person who absolutely hated anything mathematical.

While there is some correlation between mathematical talent and computer talent, the correlation is far from perfect. There are major exceptions. There is something about the fascination of the computer. I don't know a good analogue in mathematics to playing games on the computer. It is a very good way of attracting attention.

I think what's special about computers is not just that they give you a great deal of power—so does mathematics—but that you have to learn an awful lot of mathematics before you have any power. You can study math for years and years before you feel, "Gee, I can really do something." After only three months experience with computers you can do all kinds of terribly useful things with it. That I think is a very big difference.

TYCMJ: *That is probably something that can be turned to the advantage of education generally. As teachers in other departments begin using the computer, they can harness students' natural enthusiasm for computing.*

Kemeny: That has happened here. The latest figures I remember—they may be out of date—is that one-quarter of all undergraduate courses use the computer. These are courses in which the faculty require use of the computer. The students may use it in other courses on their own. These figures do not include the use of the computer for word processing, but genuine uses of computing. Remember that as an undergraduate school Dartmouth is like any liberal arts institution—maybe larger than small ones. But the distribution of courses is the same: the largest number is in the humanities, the second largest in the social sciences, and the science division is the smallest. So one-quarter of all courses is a lot of courses.

TYCMJ: *One of the social issues that people comment about frequently is that at the early ages in junior high school, when children begin working with computers, boys outnumber girls by about* 4 *or* 5 *to* 1.

Kemeny: This does not surprise me. I bet that in most junior high schools you can't use the computer without fiddling with the hardware. I would be no good at that. The typical American boy learns to fiddle with all kinds of gadgets at an early age. I hope it doesn't have something to do with masculinity because I did not have that kind of upbringing. In Hungary you didn't do those things. An American boy knows how to fix a car. I have never learned how to find out what is wrong with my car, partly because most Hungarians didn't have cars. When it comes to fiddling with gadgets, our society is certainly prejudiced towards boys.

Now at Dartmouth, I don't have to know how my terminal works. I do have to know about software, and how to write good programs. But I bet you that at the typical junior school something is not quite right about the equipment, and unless you know how to turn knobs here and there, nothing will work.

For example, in my classroom the connection between the television set and my terminal is very complicated. People haven't worked out a simple interface yet. So I always try to get a volunteer to take a lesson from the one member of the department who knows what gets hooked to what. That volunteer has always been a boy. On the other hand, the assistants that I have had have been an equal mixture of men and women.

I think this has to do with worrying about gadgetry. So it will be terribly important to get equipment in the schools where you don't have to know a thing about the hardware.

A lot of the microcomputers are, I believe, still where the big computers were when I got into it. You have to understand something about the hardware in order to make the thing work. The nice thing on a modern system is that you don't have to think about those things. Open a file and tell it to stick something in it, and you don't have to care where the computer puts it.

TYCMJ: *Let me ask about the future. There is a lot of talk about putting textbooks and even whole libraries on computers. Is it likely, say in the next ten years, that there will be major changes in the way schools deal with books?*

Kemeny: Let me tell you my other major prediction—it actually came earlier than time-sharing. This was a talk that I gave at the MIT centennial called "A Library for 2000 AD" where I predicted that the research and reference portions of a library will all be using computers. I am sure I predicted all the wrong technology about how it would happen, but the logical structure was right. You would have computer-organized searches of abstracts. Mathematical journals, for example, would not be published at all. The editor, after having accepted the article, would put it on the computer. If the Library of Congress was in charge, you would submit volume 17 on tape to the Library, and anybody who has access could just call it up.

The technology is just about here now. My prediction was that it would take 10–20 years for the technology to make it possible, and another 10–20 years for people to get around to doing it. Not only is the technology now available, but there is a tremendous economic motivation. I predict that there will be major savings except for the start-up costs. Putting all this equipment together involves enormous conversion costs. But even if it is done only prospectively, the economic incentives will never be greater than they are now. You know what research journals cost—they are totally unaffordable. There is so much junk published that you can't find what you are looking for. I think we are going to be forced to go in that direction.

Of course, I did not foresee technology like this at all. Now it should be possible, if the Dartmouth library is hooked in, for me to have an extension to it on which I can search through the Library of Congress from my office. As a matter of fact we are taking a very small step in that direction. We have a project that Dartmouth is doing for the National Research Libraries to produce one of the first on-line catalogues. They very cleverly sponsored two experiments—we are one of them. Then they can compare which one is better. It is something you cannot afford to do as a single institution. But 25 members of the National Research Libraries jointly sponsored these two experiments. We all share in the costs, and if it works we all share the benefits; if it doesn't work, we all save the money of not having each one of us go the wrong way.

We now have a new nuisance in our terminals. When I first turn my terminal on I must type where I want to be connected. That's because there are now two computers here, but it is really preparation for the fact that there are going to be four very soon because there will be a separate one for administrative uses and, more importantly, there will be one for the library.

So instead of typing C for connect, then D1 for the first Dartmouth system, this fall I should be able to type C L to get to the library computer. And then the catalogue will be available with its retrieval system. I haven't tried it, but some of my colleagues have. It is far from perfect, but they say that it is not bad.

What we have done is to start the computer catalogue from some date on. The plan is that everytime someone checks out a book, the process of checking it out will add it to the system. We have a million and a quarter volumes. Going back and cataloging them all is just crazy. But this is a natural self-correcting system—when something gets checked out, it gets added to the catalogue. If a book never gets checked out, then there is not much point in adding it to the system.

This system is very nice, terribly useful, but it means extra expense. The system I am proposing will be very nice, terribly useful, and will save money. By putting the actual contents on line, you don't force every library in the country to have a copy of, say, the *American Mathematical Monthly.*

TYCMJ: *Do you think individuals—mathematicians, philosophers, people who now read journals—will really sit down and read things on a screen?*

Kemeny: I certainly would use it for research, for deciding whether I wanted to get an article or not. Certainly the technology is here so that if you want, the same terminal (if not the one in your office, then one in the library) can produce hard copy for you. It is a modern version of demand printing. You can search the system, and if there is one you want to study carefully, then you get a hard copy of it.

This is why I was very careful to say that this is for research and reference. I don't see any advantages to having a novel in there unless you want to do textual studies. But that is a different thing. For reading Shakespeare or a history book, there is really no point in having it on computers. On the other hand, you know the statistics on research journals. Hardly anyone ever reads any particular article. You subscribe because in a given year there are two or three articles that you cannot afford to miss. For this you have to pay whatever horrendous sum the journal costs, not to mention what it costs the society to publish that journal. It just doesn't make sense.

TYCMJ: *Some of the costs are in the paper and mailing, but other major costs are in the editorial process which will still have to go on.*

Kemeny: I was flooded with letters about infringement of copyright. They wanted to know how this thing would be financed. Frankly, I hadn't thought of it when I gave the talk. But there is a very simple solution. Computers do keep track of things, so you could pay a royalty by use, not to authors (that would be too messy) but to the professional journal itself. Every time the journal is called up, you are charged 10 cents or whatever is appropriate. Certainly there will be user charges for the system—some to have access, some of it for connect time, and a portion for the journals themselves. The journals might get interesting feedback as to whether anyone is reading them.

TYCMJ: *Let's turn to your personal background. Your first book was called "A Philosopher Looks at Science," and your first appointment was in philosophy. Are you a philosopher or a mathematician?*

Kemeny: My first full-time faculty appointment at Princeton was in philosophy. That actually was an accident. All my degrees are in mathematics, but philosophy was my hobby, which I continued in graduate school. I audited courses, and I almost got a master's degree in philosophy. I had everything but the general exam. That was the year I became Einstein's assistant, so I didn't have the time to study for it. I had roughly the equivalent of a master's in philosophy, and my Ph. D. thesis was in logic which is often taught in philosophy departments. So I wasn't that far away from a Ph. D. in philosophy. But I never thought of it as anything but a hobby. When I looked for a job in 1951 the job market was about what it is now—good jobs were almost impossible to get. I was looking for jobs in mathematics; it never occurred to me to apply in philosophy. To my total surprise the only good job offer I got was from the Princeton philosophy department. So I moved 100 yards and became a philosopher. I was very happy there, until Dartmouth came along and asked me to join the mathematics department. Even then, I asked whether I could teach some philosophy, and did so for several years.

You are right that my first book was in the philosophy of science. It is essentially the lectures I developed for the philosophy of science courses I taught at Princeton and for a number of years at Dartmouth.

TYCMJ: *In earlier interviews with George Pólya and Paul Halmos, both of them made reference to their original interests in philosophy. Pólya said that he went into mathematics because he "was not good enough for philosophy," and Halmos described himself as a "downward-bound philosopher." Normally people think of mathematics being linked to physics and now-a-days to computer science. Is the link to philosophy just as close?*

Kemeny: Here you might draw the inference that it is only Hungarian mathematicians that are interested in philosophy.

TYCMJ: *That was going to be my next question.*

Kemeny: Of course there is a very high correlation. If you ask people to write down the 20 greatest philosophers of all time—none of us are in that category, so I am safe in talking about that here—you will find that quite a few of them are also great mathematicians. But if you ask them to write down the 20 greatest mathematicians, very few of them did any philosophy.

TYCMJ: *Would you infer from that any corollary about students currently studying mathematics?*

Kemeny: Because of my dual interest, I have made a certain study of it. It depends on the kind of mathematics you are interested in. The mathematicians who tend to drift towards philosophy are people who work in fairly abstract mathematics, such as logic. Certainly logic is the area that is closest to it.

TYCMJ: *What about the Hungarian connection? Why are so many great mathematicians Hungarian?*

Kemeny: It is very very hard to understand. There are a few fields in which there are an inordinate number of Hungarians—mathematics, theoretical physics, and Hollywood. I forgot who the producer in Hollywood was, with a big sign on his desk saying "Being Hungarian isn't enough; you must also have talent." Really there were an inordinate number of Hungarians that you would never have guessed were Hungarian. Take, for example, the person my wife and I always thought was the epitome of British acting, Leslie Howard. When he was killed tragically in World War II, the story of his life was printed in all the papers. It turns out that he had been born in Hungary but went to England when he was a small child.

I don't quite believe Gail Young's theory that the Hungarian language is so hard that only the brightest children manage to survive. Certainly, for mathematicians and theoretical physicists, the school system in Hungary was very good. No, that's not true. The school system in Budapest was very good. And Budapest had about

10% of the population of Hungary. Secondly, there are so many temptations for Americans to go into all kinds of fields, many of which just did not exist in Hungary. There is no way you could become a great industrialist in Hungary—there were no great industries. I don't know if there were any Hungarian millionaires at all. Medicine was very strong in Hungary, but a lawyer just didn't have the kind of opportunites you have here. And you couldn't get involved in politics. There were just fewer areas, so a larger percentage of the talented people went into fields like mathematics and physics.

But the school system had a lot to do with this. Let me give you an example. I went there through $7\frac{1}{2}$ grades. The Hungarian split is 4 and 8 (4 elementary, 8 gymnasia), not 8 and 4 as in the United States. For the last $3\frac{1}{2}$, from fifth to the middle of eighth grade, I had a mathematics teacher—it happened to be the same one—who would have been well qualified to teach at a good college. He just did an enormous amount to strengthen my interest in mathematics.

I liked mathematics before that. I don't know where I got interested in mathematics—it went way back. But being interested and knowing something is very different. This teacher was better than any teacher I had in high school in the United States—really, significantly better.

There is another interesting story about this teacher. There was a mathematical contest for high school seniors in Hungary that was a very big thing. If you were talented, I'm told, all through your last three years they would drill on practice tests. It was a great honor, not just for yourself, but for the school.

When we left for the United States, my whole class came out to the train to see me off, and my math teacher did too. It was really nice. He said something that has stuck with me all this time. He said that he was terribly happy for me that I was leaving for the United States, because he was worried about the future in Hungary. On the other hand, he said, he had only one regret. He had never had a winner in the math competition.

Look, for God's sake, I was four and a half years away from that exam, and he was already thinking that maybe I could make it to the top in the competition.

TYCMJ: *Certainly the tradition of competition has continued in Hungary, and in all of eastern Europe. The International Olympiad started there. Now the West is participating, and doing quite well. But the initiative for having the contests was with the Eastern countries.*

Kemeny: Let me contrast my experiences this way. New York City had a competition when I was in school—it was the Pi Mu Epsilon Contest. We happened to hear about it purely by chance. We heard that at other schools people got help in practicing for this exam. In our high school of 5000 students we could not get one math teacher to help us with it. So two of us went and took the exam in our junior year just to find out what was on it; then we worked the next year drilling each other.

I think I came in third. Considering that I didn't have any coaching, I thought that was pretty good. That sort of thing makes a great deal of difference. But it is incredible that in a school of 5000 students there wasn't a single teacher willing to help, let alone encourage you to take it.

TYCMJ: *Certainly the high school exams are better organized now than they were then. In New York City there is a very active league—the Atlantic Regional Mathematics League.*

Kemeny: Contests aren't everything. They are just symptomatic of the status of mathematics teaching. Problem solving is only one type of mathematical talent. I happened to be good at that, but there are very good mathematicians who are not problem solvers. I think that a system that encourages problem solving is in effect showing that mathematics is important. The Hungarian exams go way back, very far back.

TYCMJ: *Are there specific things that you think the United States should be doing? We have a real crisis in mathematics education now—few teachers, few that are well prepared, low pay, low morale. You know the litany of the problems.*

Kemeny: It is horrible. I once was Chairman of the MAA committee on teacher training. We totally bombed out on elementary school training, but we thought we made significant impact on high school teacher training. I have been away from that for a long time now. We did provide a strong program for high school teachers, but I suspect that most of them are no longer teaching high school mathematics. They can get much better jobs elsewhere.

I did not get really caught up until this spring when I was at a meeting, and heard from the chairman of the Northeast Section of the MAA all the horrible statistics. It is now much worse than what I thought was a terrible situation twenty years ago. In between, I think there were temporary improvements with the NSF institutes and other things. But the situation now is probably as bad as it has ever been during my professional life.

What you can do, I haven't got the foggiest idea—except to train more teachers. I think one has to give differential pay to teachers. But most school systems are reluctant to do that. They are much more likely to take a gym teacher who has some free time and train him to teach mathematics.

TYCMJ: *Even with differential pay, it would take a long time to develop a large pool of trained teachers.*

Kemeny: Money would help. While industrial jobs are very attractive, as you know there are a great many people really dedicated to teaching. But the salary differential that exists today between what that person can command in industry and what he could get in teaching is so enormous that it is unfair to his family. The gap doesn't have to go to zero. But if it were narrowed somewhat, I think a certain number of people might return to teaching.

And equally important, there would be much more motivation for college students to go into high school teaching. In a way, if the pay were better, this would be a good time because there are so few jobs available in colleges. This might be a time when the kind of person I had in Hungary—a person well qualified to teach in college—might go into high school teaching. But not with the kind of salaries available in high school today.

TYCMJ: *Does Dartmouth train students for secondary education in mathematics?*

Kemeny was one of the first people to have a terminal connected to a time-sharing system in his home. This photograph shows his daughter Jennifer (then in junior high school) using the terminal. She has become a computer scientist.

Kemeny: We have always felt that our major task is to give them the mathematical training. But we do have an education department and cooperative arrangements with several local schools where students can do practice teaching. You can't major in education at Dartmouth, so we are not in the elementary training business. But the students can get the minimal amount of education and practice teaching in order to get a teaching certificate.

TYCMJ: *Do you know what the numbers are like in recent years in mathematics education?*

Kemeny: We have never trained a very large number of teachers for secondary school. But I have the impression that they have gone up slightly in recent years because of the decline of opportunities in college teaching. But the numbers are not big. There is a certain degree of self-selection in this. The kind of person who gets into Dartmouth, paying the kind of tuition we have (whether through parents or through borrowing), usually wants to get a job that pays somewhat better. We have traditionally trained quite a large number of college teachers, but high school teaching just hasn't had that kind of appeal. But we do have some around.

We have a special Master's program—a Master of Arts in Liberal Studies, which is a terrible name. It is supposed to be the opposite of the Master of Arts in Teaching. The MAT program was for graduates who had the subject matter background, but needed to be certified as teachers. We did the opposite. The MALS program was for teachers who had lots of education courses but who felt weak in their subject matter. They come here four summers and get a Master's degree. Half their courses are in what they teach, and half in other things. In effect we let them take undergraduate courses toward the Master's degree, as long as it is more advanced than what they had had. It is a very successful program—it has gone on for about a decade. At least half of the people in the program have nothing to do with teaching. For people who live in the region and who would like to take courses at Dartmouth, it is a natural thing to do.

TYCMJ: *I suppose many of the teachers now are coming back to get computing courses.*

Kemeny: That is part of it. In the two courses I am teaching I have several MALS students. The elementary probability course is a natural. You don't have to be interested in mathematics teaching to be interested in probability.

TYCMJ: *You mentioned the influence of your teacher in grades 5–8. Were there others, perhaps teachers, perhaps not, who were very influential in your early years?*

Kemeny: Let me go way back. My father had a one-person import/export business. He had a male secretary/assistant, and his office was in our home. He may have been the earliest influence on me. The business didn't keep him that busy, and this young man seemed to be talented in mathematics. He would chat with me, and I seemed to be very curious about what he was doing. I still have one thing he gave me—a seven place table of logarithms. It is an old, horribly worn copy. That's not important. What matters is that at age 9 he taught me how to use logarithms. I thought they were marvelous.

That is the earliest influence I remember. Next was my Hungarian mathematics teacher. My high school I would say was a negative influence. It is the momentum I had from Hungary that carried me through high school. Princeton was a revelation. Whatever advantage I had in Hungary in the gymnasium I lost in George Washington High School in New York City. I really did not know what mathematics was until I came to Princeton.

I started at Princeton during World War II. The mathematics department had just decided that you did not have to take analytic geometry before calculus. So I signed up for calculus, and I had A. W. Tucker teach me first term calculus. I found that Princeton was not as hard as I thought, and I was nervous about what I might be missing from analytic geometry. So I signed up for analytic geometry. During the war all the young faculty were drafted, so we got senior professors. Professor Chevalley, the great topologist, was teaching analytic geometry. I am sure it was the only time in his life he taught it. He was an absolutely terrible teacher at that level. I remember there was one exam, with a 30 point score. I got 28, and the next highest score was 14. Everybody was terrified. Someone asked how many students did he normally flunk in this course. He mentioned some number, say 6. So the student said: if we get six volunteers to flunk, will you give the rest of us all D's? Of course he was a very kindly person in terms of grading. But 2/3 of his problems were terribly hard.

But imagine having gone to high school as I did, having Tucker and Chevalley both in the first semester of college. I entered in the spring, because they had high school graduation twice a year. Chevalley had another, more important influence on me. I was one of the few who cared for his course, and he soon discovered that I was abysmally ignorant of anything mathematical. Before summer vacation he asked where I lived; we lived on Long Island. He said, "Why don't you come once a week to Princeton. I'd like to teach you some mathematics." So that summer I went once a week to Princeton. He lectured to me on sets, cardinality, and point set topology. That summer was the first time I saw what mathematics was all about.

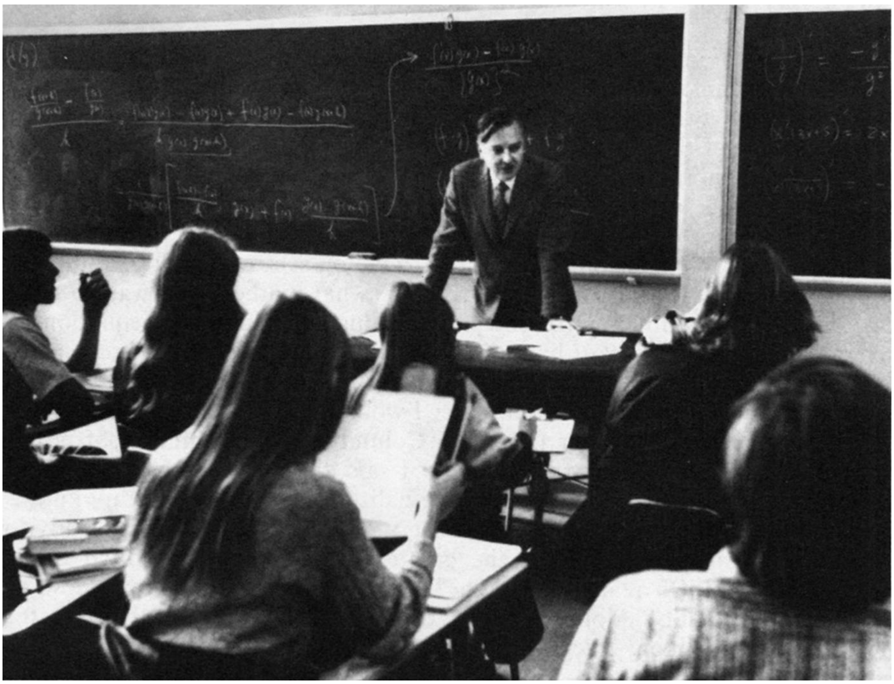
The next term I doubled up on integral calculus and differential equations. And that term something important happened to me. Let me tell you a funny story.

My interest in philosophy was strong at that time. Bertrand Russell was lecturing at Columbia, and I went to hear him. Later I would hear him several times when he lectured at Princeton. But then I went to Columbia to hear him. I sat next to a Columbia student, and we starting talking. I said that I was going to be a math major, and he asked what I was going to specialize in. I said that I didn't know, but since I had been doing a bit of reading on my own, I thought I might study logic. He said, "You lucky dog, having the greatest logician in the United States at Princeton." I said, "Oh really? Who's he?" (What would a freshman know about such things?). He said, "Alonzo Church, of course." I said, "Oh that's a strange coincidence. I am taking integral calculus and differential equations, and he is teaching both of them."

At Princeton you have to write a small junior paper and a senior thesis. I did my junior paper, my senior thesis, and my Ph. D. thesis under Church. So the single mathematician who had the greatest influence on me was Church.

TYCMJ: *You have been department chairman, and president. I am sure you have talked to students who have different reactions to teachers who are very good for the brightest students, but who are not so good for others. What's you reaction to that situation from the point of view of an administrator as compared to your reaction as a bright student?*

Kemeny: My reaction is really very simple. The only problem is with faculty who are not very good at teaching anything. I can think of very valuable faculty members at Dartmouth who are just as you described. The trick is to use them only for advanced courses. We also have some splendid faculty who are really superb at teaching the large lectures in introductory courses, but who are not so good in advanced courses. Occasionally you are lucky—Don Kreider is an example. It doesn't matter what Don teaches—he is spectacular at anything he teaches. Therefore, first of all, at a school like Dartmouth, you try not to have any faculty members who are bad at every form of teaching. And you try to get the others in a good mix. It is hard to do that in a small department, but in a large department like mathematics, as long as you have a good mix, you do fine. You try to use people where they do best.



Kemeny teaching a mathematics class during his Presidential years.

TYCMJ: *Later in your education, as a graduate student, you were Albert Einstein's assistant. But you did not go into physics. What kind of influence did he have on your career?*

Kemeny: Einstein's assistants were always mathematicians, not physicists. Obviously they were mathematicians who knew a certain amount of physics. I had taken all the undergraduate courses in physics, and had a couple of graduate level courses. I really am not a physicist, but it turned out that all of the advanced subjects in physics, the one that most fascinated me was relativity theory. I had done a lot of reading on my own.

People would ask—did you know enough physics to help Einstein? My standard line was: Einstein did not need help in physics. But contrary to popular belief, Einstein did need help in mathematics. By which I do not mean that he wasn't good at mathematics. He was very good at it, but he was not an up-to-date research level mathematician. In fact, some of the things he achieved were miraculous because he had to do original mathematics, and much of it he did the hard way.

His assistants were mathematicians for two reasons. First of all, in just ordinary calculations, anybody makes mistakes. There were many long calculations, deriving one formula from another to solve a differential equation. They go on forever. Any number of times we got the wrong answer. Sometimes one of us got the wrong answer, sometimes the other. The calculations were long enough that if you got the same answer at the end, you were confident. So he needed an assistant for that, and, frankly, I was more up-to-date in mathematics than he was.

The influences he had on me were of two kinds. I tell you, I was a little worried in graduate school because many of the first rate mathematicians were a little bit peculiar. One gets a bit of a hang-up, that you have to become peculiar in order to be a great mathematician. At least I know I had that hang-up. The same was true of some theoretical physicists. Then I met two people who changed my mind completely, and I met them fairly close to one another. One was von Neumann, certainly the greatest mathematician of that time, and he was not peculiar at all. The other was Einstein. Einstein was the kindest, nicest human being I ever met in my life.

He also once gave me terribly important advice which saved me from going the wrong way. Having worked at Los Alamos, I was terribly worried about nuclear war. I am still worried about nuclear war. But at that time I was working with the World Federalists to try to educate people about the dangers of nuclear war. They had asked me to become executive director. This happened the year I was Einstein's assistant. Einstein absolutely talked me out of it, on these grounds: with that kind of movement, he said, if you are a paid employee nobody will pay any attention to you. If you ever want to make a contribution, get to be a first rate mathematician or get to be first rate at something. Then people will listen to you on other issues as well. But the worst possible thing you can do is to work as a paid employee for a group like that.

Also when Dartmouth had an opening for a chairman—the math department sort of went out of business here—the dean talked to a lot of people. Al Tucker was deeply involved, but the two that were most influential in the final choice were von Neumann and Einstein. They really changed my life. As it turned out, they changed the history of Dartmouth College as well. The Dean got more than he bargained for.

TYCMJ: *One last topic: mathematical and scientific literacy in the United States. There have been several recent reports on this matter, from the President's Commission, from the National Academy of Sciences. One that I remember is from the report on the Commission on Public Information of the Three Mile Island Investigation. That contained a lengthy, devastating discussion of the problem that reporters have in dealing with scientific information.*

Kemeny: Absolutely. The Commission as a whole spent a remarkably long time talking about that. I don't really enjoy talking about nuclear power, but that particular incident is a very good example of why it is dangerous for average citizens to be as ignorant of science as they are.

I'll never forget our discussion of reporting on radiation. A very high percentage of public statements were unacceptable. For example they found no acceptable statements in the New York Times—and it is supposed to be a fairly good paper.

Someone on the Commission asked: "You mean they got the numbers wrong?" And the answer was no. Strangely enough, they got the numbers right but the units wrong. It turned out that they got the units wrong not only by having them, say, one thousand times as big or one thousand times as small, but they often had the wrong kind of units.

For example they did not understand the difference between total amount and rate of radiation, which was terribly important for one incident when they had indeed detected a 1200 rem radiation. The coverage had two major things wrong. First of all, that amount is what was measured right at the top of a smokestack; it is not what was measured off the island. Second, everyone said that 1200 rem was given off, which is not true at all. Actually 1200 rem *per hour* was given off for less than a minute. And that's a very big difference. Therefore, with those two mistakes the story becomes dangerously wrong.

This happened over and over again. Either some major fact like the location or the units was missing, or they garbled the units completely. It is the kind of mistake people make when they use the term light-year as a measure of time rather than of distance.

TYCMJ: *What should educators be doing about this?*

Kemeny: If mathematics teaching is in bad shape, science teaching is really in horrible shape. A survey the New York Times did a couple of years ago contained some depressing statistics. I can't remember them exactly, but roughly they found that a large majority of high school graduates never had a science course beyond general science. And those who do have something beyond tend to take biology. Almost never is it a physical science. That's madness. I can't believe there is any other western country that educates its citizens in science as badly as we do.

I'm not talking about them becoming experts in physics. But a few elementary things you have to know just to be an intelligent person. I am writing an article for *Daedelus*, the journal of the American Academy of Arts and Sciences, on the case for computer literacy as part of a special issue on scientific literacy. The editor said that others are reporting all the terrible statistics, so I did not have to do that. In this article I lead off with C. P. Snow's two cultures, not because I think his essay is that great, but his basic point is fundamental. It is not just that we are split into humanistic and scientific cultures—this is more applicable to the United States than to the England for whom he wrote it—but the terribly dangerous thing is that most scientists admit that a well-educated person should know literature, or music or whatever, while the humanistic culture is not willing to concede that understanding science is part of being a cultured individual. I think that is where the great danger comes.

TYCMJ: *That relates to the "New Liberal Arts" theme that the Sloan Foundation is talking about.*

Kemeny: At a recent Sloan conference on the New Liberal Arts, I argued for a slightly different position. I think the program is basically excellent. But I don't think they have to win over a large number of faculty to actually teach this stuff. It seems to me that students who take most of their courses in the humanities must see science, mathematics and computing. But all we can hope for is that we can get the humanities faculty to where they are not antagonistic to this material. I guess I am too pessimistic to believe that you are going to get any significant number of humanities teachers to change their teaching. But there are many humanities teachers who can come to appreciate it.

When we got our first computer, one of my very dear friends in the English department was denouncing the coming of computers. But he got the strangest kind of punishment for this behavior. Once we got the time-sharing system, we put a terminal in the high school. It turned out that in the first group of students who had access to it, by far the most brilliant programmer turned out to be his son. As a result of this, he is now extremely knowledgeable about computers, and has completely changed his mind.

Of course he is not to the point that he will teach this stuff in his courses. And he shouldn't be. If it is useful, he (and his students) will use it.

TYCMJ: *You are relatively unique among mathematicians for having served as president of a major university, and now coming back into mathematics. I wonder if there is any general advice that you would give to the mathematical community, things that you see differently now as a result of your experience as President of Dartmouth.*

Kemeny: Can I answer a slightly different question? I don't see anything different as far as mathematics goes. However certain trends are developing that I may see more clearly because I was President, trends that weren't there twelve years ago. There is a very strong trend away from mathematics. I knew this was happening, but I was shocked to see Gail Young's report [of the CBMS study] on the nationwide statistics. At Dartmouth the trends are much less noticeable.

I would have to say to mathematicians that if they are not going to learn the important applications of mathematics—not only in physical science but in the growth areas of social science and computer science—if they are not going to learn something about those areas, they are going to lose most of their students. I happen very much to believe in strong mathematics departments, so I would hate to see this happen. I don't believe it is a good thing for social scientists to teach their own mathematics. I don't think it is a good thing if computer scientists decide to go their own way and teach their own mathematics.

By all means, mathematicians should learn all the pure mathematics they want. But also they must learn applications. Get to be an expert in either the social sciences or in computer science. That's the secret of survival for mathematics departments.