A CAREER AS A SCIENTIFIC GENERALIST BASED IN MATHEMATICS

By William L. Duren, Jr.

Preface

I thank the Department for your invitation to speak on my one-hundredth birthday. Our Chairman, Ira Herbst, asked me to speak about my mathematical career, the mathematicians I have known, and the changes I have seen at Virginia and in the mathematical world.

1. Separation of Administration and Teaching. Let me begin with the biggest change in university education, which took place primarily in the 25 years after World War I, 1918-1943. Prior to that time university presidents had assembled their faculties and set the general curriculum. The great ones included Eliot and Lowell of Harvard, Angell of Yale, Woodrow Wilson of Princeton, Harper of Chicago, and Jordan of Stanford. For their faculties, they chose intellectual leaders in the public sector, great teachers, and generalists to put it all together. The last of these was Nicholas Murray Butler of Columbia. But after World War I presidents began to turn the curriculum and teaching over to departments, while they devoted their time to management, public relations, and fund raising.

In taking on this responsibility, each department has narrowed its activities to strive for excellence in its research and Ph.D. programs, while relegating undergraduate teaching to a necessary duty. Faculty members who were primarily teachers or generalists did not fit into that pattern, and have lost out in faculty selection This leaves a huge gap in the academic world, so great that the two sides have little in common, and neither understands what the other is doing or thinking.

To my mind, the worst effect of this separation is that we professors have deserted our traditional role in the making of minds, and have left the making of the American mind to the media or to religious fundamentalists.

2. A Hybrid Career. I think that the most distinctive aspect of my career is that in my own work I have not fallen into either of these separate modes, but have combined them. After floundering for some years as a mathematics instructor at Tulane University, I discovered in my work in World War II that I had special talents as a generalist, combining the mathematical way of thinking with administrative duties and other disciplines. Few real-world problems come neatly packaged in a single academic discipline. So in subsequent years I have taken on a variety of multidisciplinary problems, using my mathematician's way of thinking, but not strictly applied mathematics. I will give you some examples below.

At the same time I have held onto my role as a mathematics teacher. I taught a mathematics course every year, even when I was dean. My research has been centered on the principle of least action in mechanics and natural science. That is a long story, and

I will have to tell you about it some other time. Anyway, in following this mixed career, I call myself a scientific generalist rather than a professional mathematician.

3. How I Got Into Mathematics. In high school, I planned to be a writer, although I had represented my school at Columbus, Mississippi in plane geometry at the state competition. The teaching in algebra was not so good, so when my family moved to New Orleans I was set back from advanced algebra to beginning algebra. But there my teacher took an interest in me and taught me so well that when I returned to advanced algebra I was much better than the others. Professor H.E. Buchanan ("Doctor Buck") at Tulane University heard about me and looked me up. The result was that when I got to Tulane, I was captured into mathematics. Thereafter, scholarships, tutoring jobs, and later teaching as a graduate assistant captured me into mathematics, and I never got back to writing. It was that failure in advanced algebra when I transferred to the school in New Orleans that got me into mathematics, a strange way to choose your profession.

4. Graduate School. I had know Edward James (Eddy) McShane since high school. But we first became closely associated as graduate teaching assistants under Dr. Buck. Goursat-Hedrick had just come out and we read it, taking turns explaining it in our seminar to Dr. Buck, who did not understand it. And over in the physics department we took turns in explaining Sommerfeld's Atomic Structure and Spectral Lines to our physics professor, who did not understand it. It was an early exposition of what we now call quantum mechanics. We both learned from doing the reading and explaining to our professors, leading to a Master's degree.

Then we both moved to Chicago, where they sat us down and lectured to us. I did not prosper under this system, but they gave me a Ph.D. degree in 1930. At Chicago, I had intended to work with Prof. F.R. Moulton in celestial mechanics, but when I got there Moulton had resigned, and I switched to the calculus of variations under G.A. Bliss, the chairman. I still clung to physics, taking Nobel Prize winner Arthur Compton's course in nuclear physics.

My friends there began with a history student, my dormitory roommate, Chet Destler, who later became my brother-in-law. And in mathematics, besides McShane, my special friends included Adrian Albert ("A^3"), Saunders MacLane, and Ralph Sanger, later chairman at Kansas State University. In the faculty my special friends were Lawrence Graves and E.P. Lane, the geometer, but I took Leonard Dickson's course, and he knew me. The department's founding chairman, E.H. Moore, was still around, and he knew me too.

5. Family. Besides these mathematical friends my girl-friend from New Orleans, Mary Hardesty, was there earning her Ph.D. degree in zoology. She later became my wife, and we formed part of a hopelessly academic family. Starting with Mary's father, who was chairman of anatomy in the Tulane Medical School, including in-laws like me and Chet, and Dr. Hardesty's grandchildren, 27 people, we have 9 Ph.D.'s and two more women, though not having Ph.D.'s, have had positions for which the Ph.D. is normally required.

All three of Mary's and my kids have followed careers involving mathematics or computing, especially Peter. He has far surpassed me as a mathematician in his long-term professorship at the University of Michigan, with many published papers and graduate students. He likes to work in collaboration with authors in several countries. I can't believe it, but he has just celebrated his 70th birthday at a special conference in his honor in Spain!

6. Princeton. Let me get back to my own career. As I reported earlier, after my Ph.D. degree in 1930 I returned to the mathematical desert at Tulane trying to teach dimwits college algebra. This stultifying work experience was interrupted by a year (1936-1937) at the Institute for Advanced Study in Princeton. It was the most important year of my advanced studies in mathematics, and I made many new friends there, most especially Al Tucker, who later became my closest collaborator in our national curriculum reforms. In that I am sure we were the primary instigators of the national movement to replace the old first college course in college algebra by calculus, or by a general analysis course that included calculus. The idea was mine but I could not have got it adopted nationally coming from Tulane. But Al Tucker gave it the prestige of Princeton, which was essential to its general acceptance.

It was my knowledge of the Chicago calculus of variations that got me an appointment to the Institute for Advanced Study as assistant to Marston Morse. I wrote the notes on his lectures in Variational Theory in the Large. But my graduate education at Chicago had been deficient in topology, and my presentation of Morse Theory reflected it, I fear.

Einstein did not know me, but I had the office next to his for the year. I attended his lectures in which he explored the question: Could there be gravitational radiation associated with the force of gravity analogous to the electromagnetic radiation that derives from the electromagnetic force? His answer was that there could be, and he pointed to tensors in the relativity matrix where it could occur. Hermann Weyl did know me. I attended his lectures in generalized Lie Group Theory. I also got to know Andre? Weil, who was a visiting scholar there that year. I did not attend Von Neumann's course in Continuous Geometry. I could not make out what it was, but only years later realized that it was the first exposition of what we know as abstract functional analysis. I did attend his lectures in Self-reproducing Automata, his mathematical model of the living organism. I still think this may turn out to be his most important contribution.

And, to make up my deficiency in topology, I attended Alexander's course, but was completely baffled by it. Only years later did I realize that Alexander's lectures were the first exposition of cohomology. For Morse Theory I needed old fashioned homology.

Although Lefschetz was on leave that year–it was his office that I had–we became friends. And I got to know Gödel, the genius but strange little man. And Britain's G.H. Hardy was visiting there that year. He had a marvelous rapport with young mathematicians. I formed friendships with younger mathematicians who, besides Al Tucker, became friends for life.

If I could have stayed there I would have changed my field to group theory, and would have become de facto a student of Hermann Weyl. But it was back to teaching four classes at Tulane. In that environment, I could not continue my multiple mathematical experiences from Princeton, and settled back into my earlier teaching of dimwits and duties in the department and general Tulane faculty. This continued until 1944.

7. War Service. I was working in my "victory garden" in New Orleans when a telephone call came from Prof. E.J. Moulton at the Columbia University's wartime Curriculum Resources Group. I was asked to come there to study flexible gunnery and bombing in preparation for joining the Army Air Force as an "operations analyst." That emergency curriculum turned out to be remarkably good.

I was assigned to the Second Air Force, a training unit headquartered in Colorado Springs, given this less glamorous assignment rather than to the war theater in Europe because my wife was pregnant. But it turned out to provide scientifically more advanced opportunities for service than those jobs in the theater overseas.

The engineers had designed the B-17 "Flying Fortress" with 50-caliber machine gun turrets with which it was supposed to defend itself against enemy fighter planes. Years later, when it came out in the war in Europe that this idea would not work, we mathematicians were called in to fix it. It was far too late. The whole idea of "flexible gunnery" to defend the B-17's was a farce. A similar thing happened in "precision" bombing. As designed by the engineers, the Norden bomb sight was supposed to place the bomb within 10 feet of the target from an altitude of 10 thousand feet. In actual combat the average error turned out to be something like 2 miles, not 10 feet. And when we mathematicians were called in, it was too late to fix it.

On the gunnery defense of the B-17, B-24, and later B-29, I was able to show mathematically that our gunners were shooting down more of their buddies nearby than enemy fighters. It was also provable mathematically that a Japanese fighter attacking off beam had a very small probability of hitting the bomber, due to the distance and the severe forces of acceleration to which he was subject in holding a guns-bearing attack.. So my answer, which became part of standard operating procedure of the B-29, was to limit defensive fire to a small cone forward and rear, where the fighter attack was dangerous, where your defensive fire was more effective, and where you avoided shooting down your buddy nearby in the formation.

I got a response from that report from a younger mathematical analyst in Guam, George Nicholson, whom I had apprenticed in the 2nd Air Force. He said: "That was a nice report, Bill, but we have taken the guns out of the airplane to make room for more bombs. Why don't you go back to Tulane?" And I began to make preparations to do just that.

But, before I took leave, the important issue of whether to use the atom bomb came up. General LeMay in the Marianas sent an emissary to the 2nd Air Force urging that it stop training and send all its B-29s to the Marianas where their added firepower would let the U.S. finish the war with Japan without using "the cataclysmic weapon," that is, the atom bomb. The 2nd Air Force command had a nice thing going with its country club locations, and no intention of going over to the war theater. So they sent Gen. LeMay's messenger to see me. He sat at my desk and actually cried in frustration.

The issue of avoiding the use of the atom bomb came up in another way too. Russian air force officers made contact with American air force officers, offering the use of their air bases near Vladivostok. The B-17's and B-24's from the war in Germany could not reach Japan from the bases in the Marianas. But they could from the Russian bases on the Kamchatka Peninsula This would vastly increase the American force against Japan with thousands of airplanes and experienced crew to fly them. And without deploying the atom bomb! A command crew was flying to meet the Russians when they were stopped in Alaska by order of President Truman. This story is little known. I know about it because I was asked to join the operations analysis group in the Russian bases.

President Truman hated the Soviets more than he hated the Japanese. I believe he ordered the dropping of the atom bomb (on Hiroshima) in order to win the war quickly without any help from, or credit to, the Soviets. The official version still says that the reason was to finish the war without having to invade Japan with the loss of many American lives.

But, as we have seen above, that was not going to happen. The war was already won with conventional air power, not employing the atom bomb. The Japanese air force was destroyed, and their supership, the Yamamoto, had been sunk. The Americans had occupied Okinawa and were steadily advancing toward Japan. The Japanese had already made overtures for peace at the conference in Potsdam that concluded the war in Europe.

I knew Col. (later Gen.) Paul Tibbets, the pilot of the Enola Gay, which dropped the atom bomb on Hiroshima. I had flown with him earlier when he was the commander of the air base at Grand Island, Nebraska. We were testing a scheme for the defense of the B-29. And I knew when he was promoted and put in charge of a mysterious new project.

When the test atomic explosion in New Mexico was about to take place he sent an airplane to bring me there. But I missed it because I had gone on a project to Eglin Field in Florida, stopping off in New Orleans to see my new son, David. I am sure that Paul Tibbets, contrary to my view of it, thought that his mission in August, 1945, avoided a costly invasion of Japan. I think that dropping the atom bomb on Hiroshima brought the quick Japanese surrender, and perhaps saved millions of lives, Japanese lives, not American. It saved relatively few American lives.

In terms of energy per gram of fuel, atomic energy is a revolution of the order of 10^7. That factor is so great that we, even yet, cannot perceive its ultimate consequences. The industrial revolution of the 19th century, with its enormous consequences for human civilization, had been fueled by steam power, which was an energy revolution only of the order of 10^3 over the previous horse-power technology.

And besides the atomic energy revolution, we knew then the possibilities implied by biological weapons, such as anthrax. They may be even more threatening to the survival of human civilization than atomic energy. But, so far as I know, biological weaponry cannot be evaluated as being a revolution of the order of some power of ten.

As I left the Air Force in late summer of 1944 to go back to Tulane, my files were destroyed for security reasons. They contained two items that I wish I could have kept. One was my A.G.O. card which said I had the "assimilated" rank of colonel. The other was an order, signed by "Eisenhower", ordering me to the 8th Air Force with headquarters in Britain, which I disobeyed. My work was then concerned with the B-29 and the war with Japan.

I do have a letter of dismissal from the commanding general of the Air Force, thanking me for my service and elaborating on my contributions in some detail.

8. Curriculum Reform. I discovered, from the success of my war experiences, that my talents lay not so much in mathematics itself as in general scientific knowledge, and skills in administration, using mathematics as only one tool. So I built my subsequent career around these abilities.

I was of two minds about continuing at Tulane in New Orleans. Although it was my university, and I was established there, I knew that Tulane's finances were weak with its inadequate endowment. And in the back of my mind I was looking for a way out of New Orleans, protected only by fragile levees from Mississippi River floods, such as the one in 1927, and from hurricanes driving water from the Gulf or Lake Ponchartrain. But I had not found a way out, so I had to start over at Tulane.

I realized that the loss of mathematicians in war service, together with the new demand for applied mathematicians in government and industry, had drained our national resources at the Ph.D level. There was both a need and an opportunity to get into graduate work to the doctorate. So our first postwar move was to establish a Ph.D. program in mathematics, Tulane's first in arts and sciences. We were ahead of the game in realizing this, so we got students from all over the country, especially the South. Our financing came from O.N.R. grants, with the aid of Mina Rees, and G.I. Bill tuition. Our most productive faculty member was A.D. Wallace. B.J. Pettis and Marie Weiss (from Newcomb College) also played major roles. And we were later joined by J. L. Kelley, fleeing from a loyalty oath wrangle at Berkeley.

But nearly all of those first students failed in graduate work, revealing a severe weakness in undergraduate teaching in the regional universities without graduate programs. Our first response to this was to establish the national curriculum committee (C.U.P., CUPM) on the Undergraduate Program in Mathematics. As I indicated above, this is where Al Tucker joined in bringing the essential prestige of Princeton to it, as well as his own passionate devotion.

We partitioned CUPM into panels, each devoted to a special area such as social studies, engineering and physical science, besides the basic ones in mathematics itself. John Kemeny became a leader in the social studies curriculum. Although we mathematicians were first in this postwar curriculum study, other national disciplines soon followed suit.

But I think that the most important move of CUPM was to establish calculus as the standard first course in mathematics in college. Previously that had been college algebra, trigonometry, and analytic geometry, designed to prepare for calculus in the second year. Too much of that was repetition of high school mathematics, but not all of it. So CUPM had to design a course, primarily calculus, but including some analysis prerequisites to calculus. We wrote a model text for it called "Universal Mathematics." Since then there have been many commercial texts for the nearly universal first-year calculus.

9. Regional Development. It was not enough to recommend a modern curriculum if the teachers were not prepared for it. So one of CUPM's early moves was to call for the Ph.D. degree as required qualification for a tenured position in the faculty. I cannot claim that CUPM was first to do this. It was a national move across all of the disciplines after World War II, but we gave a boost to it. And more generally, not only in CUPM but in all my work in the mathematics profession, regional development remained a major theme.

Seeing our success at Tulane, many colleges and universities around the country, who had been restricted to the B.A. and M.A. degrees, now initiated Ph.D. programs of their own. This meant that our Tulane Ph.D.'s did not go into college teaching, but became professors in new graduate schools. And it also meant that they kept their students, and Tulane was no longer able to get the cream of the crop from our wide region.

10. NSF. I think it was in recognition of our accomplishments that I became the first Program Director in Mathematics (1952) in the then-new National Science Foundation. In that role I continued to emphasize regional development. For example I was able to establish a series of largely departmental grants, each headed by a senior professor but providing for the support of graduate students and assistant professors.

This brought criticism from the Ivy League universities. They claimed that all grants should be made on basis of mathematical quality. Admittedly my departmental grants could go to regional universities that did not match Harvard or Princeton in quality. But the Ivy League universities could produce only a few Ph.D.s, while by far the greater number of talented young mathematicians were out in "the sticks." My departmental grants would produce many more Ph.D.s for universities, government and industry. In short they expanded graduate mathematics nationwide. Moreover it raised the level of mathematics throughout the country.

We were also able to set up "Summer Institutes" of about 12 weeks in which faculty from departments around the country could come for renewal or advancement of their mathematical skills. This was done through the Education Division of N.S.F. Again, mathematics was first, but other disciplines soon came on.

The first Summer Institute in mathematics was organized by Burton Jones of the University of Colorado, and was held at Colorado Springs with Emil Artin as its principal professor. Baley Price of Kansas University also proposed one, and I think conducted Summer Institutes in later years.

Something new, call the <u>computer</u>, showed up. As program director in mathematics I had to write a report recommending whether the government should support it as it had supported atomic energy, or not. The experts said that, compared with atomic energy which had been an energy revolution of the order of 10^7, the computer was an <u>information</u> revolution of the order of 10^{10}, a thousand times greater.

I thought that this was dangerous to American society, and wrote a report urging that the government <u>not</u> support it, but leave it to slower development in private industry. Nobody ever read my report, which I suppose is still there buried 50 years deep in NSF files. Of course NSF supported it! And of course university administrations and faculty wanted it supported for the grant of money that came with it. And it turned out that the slow-down I wanted was provided by the years it took to develop the software.

<u>11. Racial Integration.</u> I started with the Louisiana-Mississippi meetings of the college mathematics teachers. Black college teachers were not included. My motion to invite <u>all</u> college teachers to our meetings passed. The first integrated meeting was to be held at the University of Southwestern Louisiana at Lafayette. Zeke Loflin, the chairman there, was in favor of it but made the mistake of asking his president's approval. It was denied. And Zeke contacted me in desperation saying <u>I</u> would have to have the meetings at Tulane. I did not ask my president's approval; and we held the first integrated meeting of college teachers in that part of the country.

But my own college was still segregated. My faculty motion, calling on the Board of Trustees to admit black students to Tulane, was modified by my weak-kneed faculty colleagues to ask the Board to <u>consider</u> admitting blacks. Presently the word came back from the Board: "We have considered it." And I started looking for another job. That was when the job of dean of Arts and Sciences at Virginia showed up.

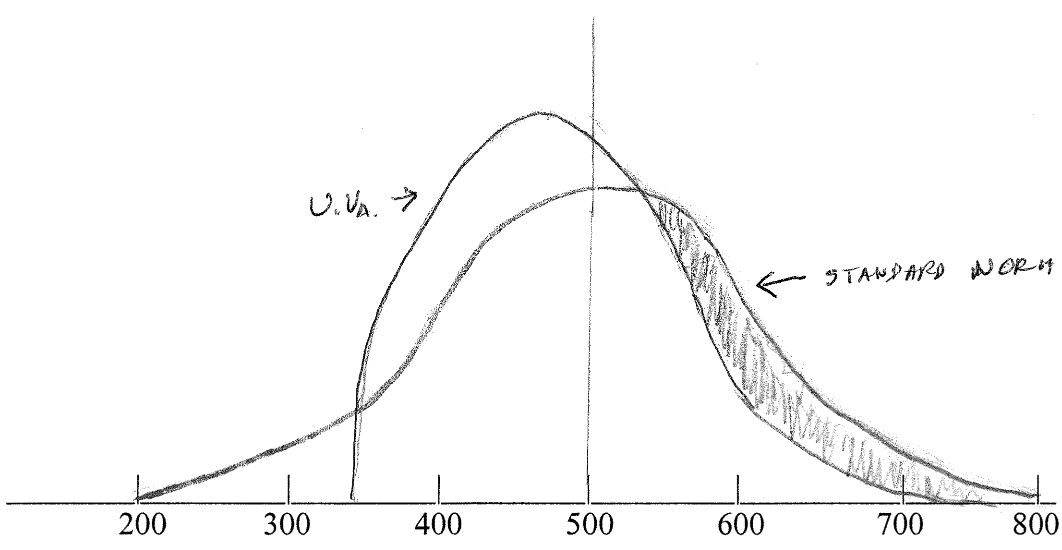
In coming for an interview I checked that Virginia was integrated in the dorms, the dining halls, and classrooms but forgot to ask about my own college. It turned out that President Colgate Darden had integrated the professional schools but ruled that the black college of arts and sciences at Petersburg was "separate but equal." So I had come from segregated Tulane to segregated Virginia! And, as dean, I did not control admissions. That responsibility was retained by President Darden.

However, my associate, Irby Cauthen, and I found that we did control admissions by transfer from other colleges. So we started looking for a black student who applied for transfer to the College and had College Board (SAT) scores that indicated he would succeed in earning a degree. It took us years to find him. The SAT scores of black students were dismally low, usually in the 200-range, three standard deviations below the national mean. But we finally found Mr. Willis, who wanted to transfer from Engineering. Our recommendation to admit him was approved by the Board of Visitors. So we broke the segregation of the College.

A couple of years later the College was opened for black students entering from high school.

12. Mathematician as Dean of Arts and Sciences. Since our chairman asked me to speak specifically about my role as a mathematician, let me tell you a couple of stories about how being a mathematician affected my job as dean. I don't think that a historian or literary scholar as dean would have done these things.

First, I made a graph comparing the SAT scores of entering students in the college with the standard national distributions of SAT scores. It looked like this:



The Virginia distribution had a maximum below 500, and it fell below the standard distribution in the scores above about 550 (shaded area in the graph). There was a fairly good cut-off of about 350 at the lower end. But I was amazed that Virginia was admitting so many with SAT scores below 500.

To correct the deficiency in the upper range we created the Echols Scholar program. Over the years this has been very successful in attracting and rewarding superior students.

But all those students with scores below 500! Why were they there? And what happened to them? It turned out that they were there to build up the tuition–paying enrollment to a point that would justify the new buildings and facilities that President Darden had installed. Many of them were prep-school graduates who had been rejected by the Ivy League universities. They made fairly good grades in the first year, but their graduation rate was very poor.

I did not control admissions. President Darden retained that authority. But I did have some influence with the incoming admissions officer, Ray Bice, who was an assistant professor in my faculty. So I asked Ray to give me some 60 more entering students each year, but to <u>raise</u> their average SAT scores by a fixed amount. And he did it! Ray Bice is due the credit for turning around that dismal quality of admissions. It turned out also that we were admitting many students by transfer who had failed elsewhere. They were the worst candidates for graduation! So I asked Ray to turn down all admissions by transfer unless the student came with a previous C- average or better. And he did that!

When I came, the SAT test was not required for admission. But I asked Ray to reinstate it with Mr. Darden's reluctant agreement. The foreign language requirement for admission had also been dropped. And by action of the faculty we restored it. That was important not only for our own quality but also to support the teaching of foreign languages in Virginia's public schools.

Contrary to what we professors think, the students do not come to college to study our specific subjects. But it is important that we demand good academic work from them for discipline and for developing their minds. Most students have two motivations: to share the college experience, and to get a degree as a job qualification. I thought our college experience was good. Our students loved their lives at U.Va. but only the academic part of the college experience was my responsibility. My main job was to put quality into the Virginia degree. That, of course, requires a good faculty and a demanding curriculum. But it is even more important that the students themselves be of superior quality and achievement in order to create an environment that is competitive and rewarding.

Over the years the Virginia degree has come to be recognized as among the best, especially in comparison with other state universities.

Let me give you another example of our use of mathematics in administration. When we were proposing to the faculty that a new requirement for graduation replace an older one, we compared the old and new rules by applying both of them to the records of a class that had entered four years earlier. In a 2 x 2 matrix we displayed the percentages of the sample, under old and new rules, who would:

$$\begin{bmatrix} \text{pass old and pass new} & \text{pass old and fail new} \\ \\ \text{fail old and pass new} & \text{fail old and fail new} \end{bmatrix}$$

As I recall it, the sum of the two numbers on the main diagonal was about 85 percent, which showed that the new rule would change a student's graduation status in only 15 percent of the cases.

The most interesting figure was the percentage who would pass under the old rules, but fail under the new. When the secretary read the names of the people in this category the older faculty members remembered them as bad actors. And the new rule was adopted by acclamation.

This is by no means a complete account of my deaning work, but only some illustrations of mathematical thought in it. However, let me briefly list some of the innovations that we introduced to improve the quality of college education at UVA.

Besides the measures to improve the student body, including the Echols Scholar program and the measures to upgrade admissions, I regarded the policy of <u>maximizing the graduation rate</u> as the most important principle of my service in administration.

Another major interest was in libraries, and increasing the students' use of them. We had no students' library like Harvard's Lamont, which I visited. So we first established the reading room under old Cabell Hall, and later the Science Library in the former Law School building. Also we converted small classrooms into departmental libraries, and encouraged their establishment with budget allocations. I asked departments to restore the term papers in advanced courses, where they had slipped into teaching by lecture only. The departments were glad to do it. But our biggest library project was to set up a long term budget process which ultimately produced the Clemons Library for students.

I was astonished to find that the College had almost no large lecture halls. I wanted them for distinguished professors as well as for economy in teaching. So in every new classroom building we made sure it included a large lecture hall accessible to the campus so that we could situate lectures in it from any discipline.

We also brought the first computer to the College. You had to get a grant to do it. I used my NSF experience to start us in computing, with Alan Batson as the first administrator. Now, of course, computers are all over the place.

To maximize the graduation rate we had to stabilize the system of advising and monitoring of students over the long term. Harvard and Yale do this through residence halls like the British universities. Princeton does it with its dining halls. But U.Va. had no advisory service leading to graduation. We could assign our students to a dormitory only in the first year. So we used this to establish our "associations." An association was a body of students who lived in the same pair of dorms in the first year; and it was named for that dorm, such as the Paige-Echols Association which housed the Echols Scholars. Each association had an "association dean" who stayed as his students' academic advisor all the way to graduation. We had four of them. To avoid unfair special decisions on individual students by different association deans, we made all special decisions together in our regular Tuesday meetings of the association deans and myself.

We did not let students accumulate deficiencies which would deny them the degree as they came to the end. Instead, we suspended them when they fell 15 grade points below satisfactory (normal) progress towards graduation. They could be reinstated if they made up the deficiency in our summer school, or other approved college program. The affected students hated it, but these actions saved many a student before it was too late. And they were a major factor in increasing the graduation rate from the dismal 55 percent when we started to something like 78 percent when I left the deanship. Now President Casteen reports that it is more than 90 percent.

With departments choosing their professors you find that they pick specialists in their fields, and not Virginia alumni who maintain the "UVA" character of our college. Departments also neglect personal teachers and generalists. And they never introduce new teaching in fields not represented by the existing departments.

U.Va.'s tradition of departmental autonomy put the departmental budgets out of reach for me to correct these deficiencies. But I found that there were some 25 positions in the budget that had never been filled. They just sat there. So I gathered them up and used them for those neglected services. The Comptroller, V. Shea, never forgave me!

I used one of them to establish a new professorship of writing in the English department and another to initiate a new department of Asian studies. An important use of them was to find Virginians who had got their Ph.D.'s in the great universities of the world and were now ready to come home. This was my way of preserving the Virginia character of U.Va. People usually thought of the Honor System as representing our special character. The first one of the Virginians I brought home was Edgar Shannon, who became our next president. And my special professors also later turned out to have included the faculty chairman of athletics, the dean of the graduate school, the head of the residence-hall advisory system, and the chairman of the department of Biology.

<u>13. University Professor.</u> After continuing a year as dean to help President Shannon get started, I wanted out. And I wanted to be free to go elsewhere in the University. So I invented the title "University Professor", and President Shannon appointed me as the first one.

V. Shea had moved my computer and its services to Engineering. So I took my University Professorship to Engineering to initiate a new department of applied mathematics and computer science. And I got Bob Owens from N.S.F. in Washington to be its chairman. Alan Batson continued as director of the computer center itself. Batson's first Ph.D. in the new program was William Wulf, who later went on to be president of the National Academy of Engineering.

Some years later the department was split by the university administration, and the applied mathematics part was merged into the A. and S. Department of Mathematics. The computer science part remained in Engineering, and at last count had some 30 members.

During this period an interdepartmental program was initiated in Biomedical Engineering. I joined it as a member. In the techniques involved, it turned out that my wartime operations analysis was essential. And I directed the dissertation research of two students in this field, one of whom later became Vice President of the University in charge of operations.

In this way I found myself the scientific adviser of a number of students who were nominally students of a professor who did not understand their work. The only Ph.D. student in my 15 Engineering years as University Professor who was my own student was Ronald J. Hartberger. He has had a long career as an engineering statistician in the oil industry.

Also during this period I revived my old wartime operations analysis to serve as a member of the board of Analytical Services Inc. (ANSER), which was a "think tank" in Northern Virginia providing analyses for the Defense Department. In this role I sought ways to extend the techniques of operations analysis to such fields as the distribution of national health services.

<u>14. Admission of Women.</u> During the years as dean of Arts and Sciences I seized every opportunity to push for the admission of women although, as I have said before, I did not control admission to my college. We did not succeed in getting it done.

The prevailing American view was that high school and college should be coeducational, for this provides the most natural way for young people to find their life partners while working together in studies on a day-to-day basis. Dormitories can be separate. Virginia was the last state university to maintain separate colleges for the two sexes. Virginia's women's college was in another city. That involved automobile driving (often drunken) to get together, and drunkenness at the parties.

But finally a university committee was appointed by President Shannon to decide whether women should be admitted to the College. D. Runk opposed it on grounds that women were inferior as students, and President Shannon appeared to take this stupid idea seriously. I was called back to testify, and I came with evidence from Duke University, William & Mary, and UNC, all of which had found that their female students were slightly superior to the men. In fact the only way that we could improve on the quality of our student body was to admit women. And I restated the basic argument for a coeducational college as forcefully as I could. Members of the committee said afterward that my presentation was decisive in their decision to make the College coeducational.

Published accounts of these activities include:

W.L. Duren, Jr., *Mathematics in American Society, 1888-1988,* in *A Century of Mathematics in America*, Part II, AMS, 1988.

W. L. Duren, Jr., *Memoirs of a Lay Mathematician*, in *A Century of Mathematics Meetings*, AMS, 1996.

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Postscript

These activities brought me such recognition as:

- Letters in football and track, F?? as undergraduate at Tulane, 1922-1926;
- B.A. Tulane 1926, Ph.D. Chicago 1930;
- Associate, Institute for Advanced Study, Princeton, 1936;
- First Program Director in Mathematics, National Science Foundation, 1952:
- President of Mathematical Association of America (MAA) 1955-1956;
- Vice President, AAAS, Sec. A (Math), 1960;
- First Chairman, AMS-MAA Committee on Employment and Educational Policy;
- First University Professor, U.Va., 1962-1976;

And such citations as:

- LLD degree (honorary), Tulane 1959;
- Citation for war service as operations analyst, U.S. Army Air Force, 1944 (assimilated rank, colonel);
- MAA Citation for Distinguished Service, 1967.