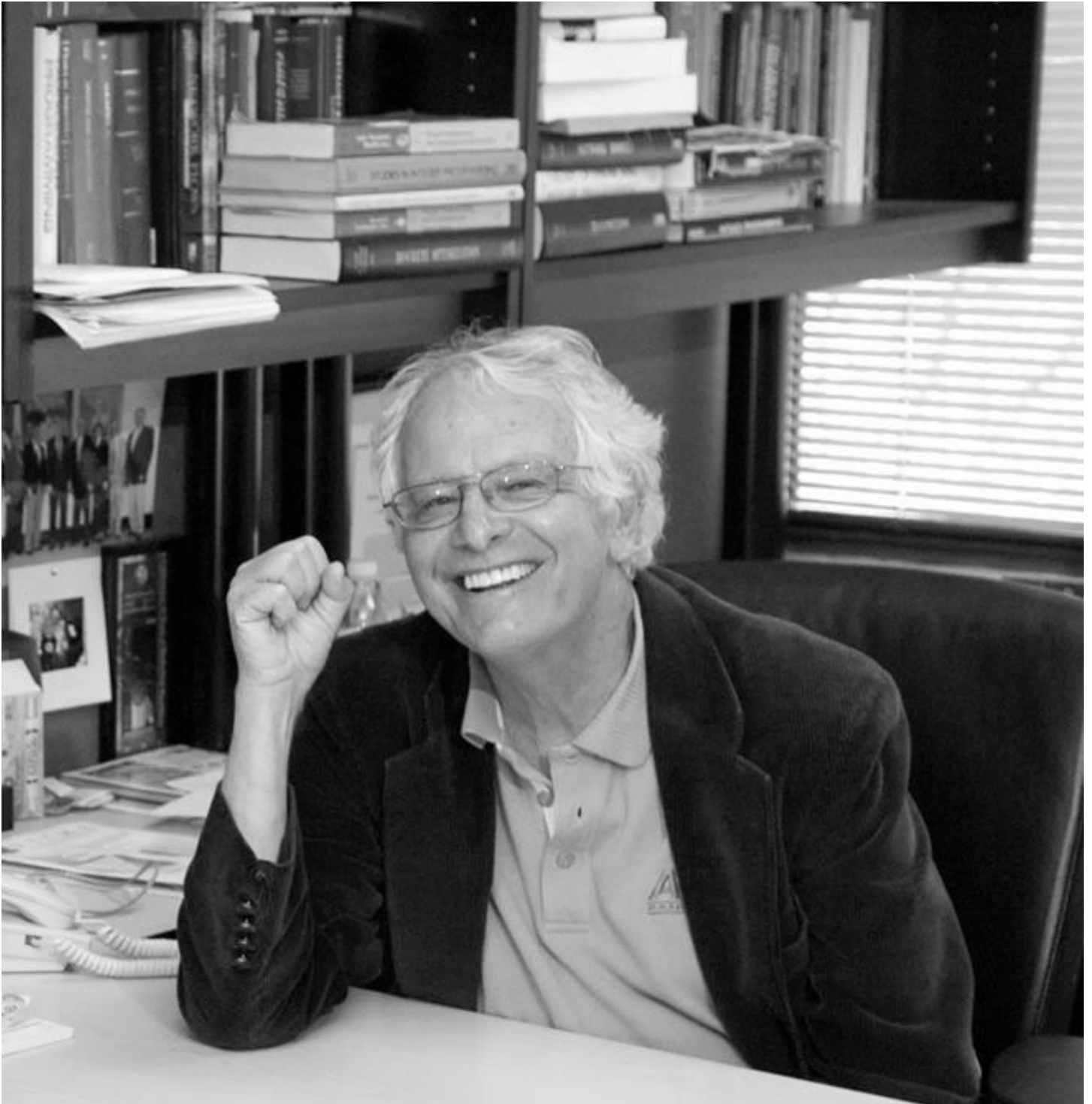


FROM SHAKESPEARE AVE IN THE BRONX TO NORTH AVE IN THE ATL



Celebrating a Lifetime
of Academic Contributions
to Operations Research

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George
Nemhauser

TECH-TECH

FROM SHAKESPEARE AVE IN THE BRONX TO NORTH AVE IN THE ATL

This is a story about George L. Nemhauser, the A. Russell Chandler III Chair and Institute Professor in Georgia Tech's Stewart School of Industrial & Systems Engineering (ISyE). It's not a story that recycles his lengthy list of notable professional accomplishments; rather, it reveals what his presence on the ISyE faculty has meant in terms of leaving what, by any fair-minded assessment, has proven to be not only an indelible mark of quality, but one that has been fundamentally transformative to the School. On the occasion of his having been honored with the prestigious Class of 1934 Distinguished Professor Award, and, accordingly, being invited to give Georgia Tech's graduate commencement address for fall 2015, this is that story.

The Bronx and Manhattan to Evanston to Baltimore to Ithaca

George Nemhauser was born and raised in the Bronx. Growing up in the shadow of Yankee Stadium, he claims to have had designs on stepping in to replace his childhood idol, New York Yankees legend Joe DiMaggio. Unfortunately, the Yankees somehow forgot to make the call — a young Mickey Mantle may have influenced the oversight — so George made other plans. After graduating from the famed Bronx High School of Science, he enrolled at the equally renowned City College of New York (CCNY), from which he earned a degree in chemical engineering. After graduating from CCNY, he pursued graduate studies at Northwestern University, conducting his work in the newly emerging academic discipline of operations research (OR) under the direction of Jack Mitten, one of the field's important figures at the time.

Upon taking the Ph.D. in 1961, George joined the faculty at Johns Hopkins University in what was then one of the premier OR programs in the country. In his early to mid-twenties, after he joined the Hopkins faculty, he was often mistaken for a student. A famous story recounts how a prospective doctoral student knocked at George's door, inquiring where he might find Professor Nemhauser, whereupon the youthful-looking guy behind the desk said, "He's very shy. He often hides under his desk. Look for him there."

In 1970, George left Johns Hopkins to join the faculty in the highly acclaimed School of Operations Research and Industrial Engineering (OR&IE) at Cornell University. There, he worked with some of the major figures in the OR community — perhaps most notably Ray Fulkerson. Fulkerson was one of the discipline's giants, commonly identified as a founding influence in the theory of network flows, and a pioneer in creating the field of polyhedral combinatorics. During his stint at Cornell, George amassed an impressive record of scholarly production that garnered some of the discipline's most-prized honors and awards. Eventually, he was named

the Leon Welch Professor of Engineering. He also advised numerous Ph.D. students, some of whom also took up academic careers in OR at prestigious institutions. In 1985, after chairing OR&IE for six years, George pulled up stakes, leaving the harsh though beautiful winters of Upstate New York, and headed south.

ISyE Circa 1985

The Stewart School of Industrial & Systems Engineering at Tech was created in 1945 as the Department of Industrial Engineering. Always a strong program, its presence among traditional industrial engineering academic programs was well-established, and its substantial reputation was well-deserved. Even into the late seventies, ISyE was inclined to count as its peer competitors similar fine programs as the likes of Purdue, Penn State, Virginia Tech, and Texas A&M. But in the world of ranking high-powered OR programs — institutions such as Stanford, Berkeley, Cornell, MIT, and Columbia — ISyE was not a major competitor. Without doubt, ISyE counted among its faculty a few notable OR scholars — Mike Shetty and Mo Bazaraa in nonlinear optimization; John Jarvis in linear programming and network flows; Ed Unger and Ron Rardin in integer programming; and Bob Cooper in queueing theory — but, by and large, the general OR reputation of the School was heavily informed by teaching and research within the context of applications. This was especially true of those commonly identified with traditional industrial engineering domains, i.e., production, inventory, material handling, factory layout, engineering economy, quality control, etc. In general, focused theoretical research activities in OR tended to be viewed as playing supporting roles rather than primary ones in the School's programmatic profile, and especially in terms of its model for the recruitment of young faculty and doctoral students.

In 1978, Michael Thomas was named as School Chair, replacing the retiring Robert Lehrer. Interestingly, both men had connections to George: Lehrer had been the chair at Northwestern when George was pursuing his doctoral studies, and Thomas had actually been one of George's first Ph.D. students at Johns Hopkins. Once at ISyE, Thomas wasted little time in adding OR strength to the faculty. He quickly brought in brand-new Ph.D.s from the OR programs at Cornell, MIT, Stanford, and Berkeley, as well as highly regarded senior people like H. Don Ratliff (Ph.D. from Johns Hopkins) in network flows and Dick Serfozo (Ph.D. from Northwestern) in applied probability and stochastics.

Then, in 1985 — and armed with a newly established endowed chair named for its benefactor, ISyE graduate A. Russell Chandler III — Thomas lured George Nemhauser to Georgia Tech. Not only was the Chandler Chair the first endowed position in ISyE's history, it was one of the first endowed faculty chairs at Georgia Tech. As part of the enticement to leave the elite, firmly established academic program that was Cornell's School of OR&IE, Thomas made it clear to George that he would play a substantive role in looking for opportunities to shift ISyE's trajectory in the direction of joining the ranks of those elites.

A Hard Job Well Done

Actions that have a substantive and transformational impact on an academic program, particularly a large and well-established one, do not involve quick fixes, nor can they be expected to produce results that happen overnight. Adding superstar faculty is an important start and can have an immediate, surface-level effect — elevating a program’s visibility, but fundamentally altering core programmatic and structural aspects of a program requires activism. Needed is an understanding of what constitutes academic quality at the top-tier level, a genuine belief that serious change can actually be effected, and a willingness to take on the difficult job of putting into place a structure that facilitates a program’s elevation. However, activism that captures those qualities is a rare commodity in academe. Required is a strong, credible voice that is not reluctant to be raised when needed, backed by a proven track record, as well as a willingness to take the lead in stepping up. Required is someone like George Nemhauser.

“It is unusual for any academic program, like Georgia Tech’s ISyE, to become top-tiered in a short period. It is no coincidence that this rise has taken place in parallel with the arrival of my dear friend, George Nemhauser. Quality follows him wherever he goes and in whatever he does, and the presence of someone of his stature and infectious disposition at ISyE has shined a beacon onto the academic community and been a magnet for attracting top-flight faculty and doctoral students that are essential to any leading academic program.”

— Tom Magnanti, Institute Professor and former Dean of Engineering, MIT; member, National Academy of Engineering

Acting on Thomas’s request that he seek out ways to enhance ISyE’s chances of joining the small band of elite programs like Stanford, MIT, Berkeley, Columbia, and yes, Cornell, George indeed stepped up. There were a few speedbumps along the way. There were some nontrivial headwinds, derived from concerns born of the natural fear of change, and others who opined that ISyE was being “Cornellicised.” Fortunately, a large portion of the faculty were not only ready but anxious to embrace change, particularly if such change managed to preserve the best of what had been an historical strength of the School, while developing its ability to be a legitimate force among the great OR-centric programs identified above.

One of the early actions directly led by George was pedagogical. Stemming from the disentanglement of the doctoral and master’s programs of study — including the direct admission of qualified students to the doctoral program immediately after their undergraduate work — students seeking the Ph.D. in all but a small number of concentrations were directed to a separate programmatic track. This added methodological rigor through a newly created set of core courses in optimization and stochastics. Others had attempted similar changes earlier but struggled to gain traction. Though by no means an easy task, George was able to pull it off.

At about the same time, and recognizing, in the late eighties, the emergence of commonalities at the growing intersection of academic research in theoretical computer science, discrete mathematics, and optimization, George was one of the foundational organizers in the creation

of the prestigious Algorithms, Combinatorics, and Optimization Program (ACO), a joint doctoral program supported by ISyE, the School of Mathematics, and the College of Computing. Vibrant and healthy, and still only one of two such degree programs in the country, ACO continues to attract exceptional Ph.D. students, and is commonly recognized as the model for high-quality interdisciplinary doctoral programs at Tech.

George's presence in ISyE was certainly not unnoticed by other academic luminaries. Highly regarded professors at top schools, previously reluctant to do so, began to point their best students in the School's direction, whether as a place for doctoral study, or in the case of new Ph.D. graduates, as an opportunity for faculty employment. In 1995, and certainly facilitated by George's presence, ISyE was able to attract one of the world's best-known research scholars in the important OR subdiscipline of integer programming, Ellis Johnson. Named to the Coca-Cola Chair, Johnson was also a member of the prestigious National Academy of Engineering. In fact, he became ISyE's second member. George was the first, and also remarkably, Georgia Tech's first sitting faculty member to have been elected to the National Academy. Long-time academic colleagues in their research disciplines, George and Johnson joined together in alerting the academic world that OR in ISyE was ready to contend for a place at the table of top-tier programs.

Throughout the nineties, now under the direction of John Jarvis, who had taken over when Thomas moved up to what would become the provost's position at Tech, the visibility of ISyE's academic and research programs steadily improved. Ph.D. applications from elite candidates evolved from sparse to steady to expected. The pattern was repeated regarding the recruitment of exceptional applicants for faculty positions — indeed, a number of hires were made that even a half-dozen years earlier would have at best been longshots. Elite doctoral applicants began to accept admission, and many others had ISyE on their very short list, even if they ultimately opted for the likes of MIT, Stanford, or Cornell. In short, ISyE was now becoming a potential destination for the best and the brightest Ph.D. applicants and young faculty candidates. Squarely in the middle of this activity was the influence of George Nemhauser.

When Jarvis retired in 2001, the chairmanship of ISyE was turned over to Bill Rouse who supported continuing ISyE's great momentum directed toward cementing its place among the top programs in the country. Arguably the first decade of the twenty-first century ushered in a golden age of Ph.D. student recruitment — an evolution supported and nurtured in the Thomas–Jarvis era, with the admission of some exceptional doctoral students — students who did choose ISyE over similar offers from MIT, Cornell, Columbia, etc. But this also was the decade that brought to ISyE three of its most acclaimed senior faculty hires ever, all arguably the world's best in their respective fields: Bill Cook in computational optimization, Arkadi Nemirovski in convex optimization, and Jeff Wu in industrial statistics. Ask all three if George's presence influenced their decisions to come to Georgia Tech.

“It was certainly George, and the activity he created, that attracted me to Georgia Tech. George made Tech the place to be for optimization research.”

— Bill Cook, University Professor, Department of Combinatorics and Optimization, University of Waterloo; member, National Academy of Engineering

George’s positive effect on ISyE’s rise in prestige results not just from his own reputation, but from his inherent inability to sit on the sidelines. He works hard to recruit terrific students and faculty; he mentors the dissertation efforts of Ph.D. students who seek his advisement (and who are up to the challenge); and he actively engages other faculty, especially younger colleagues, as co-research advisors for those students. This results in a true win-win-win model of doctoral research advisement in the School. He talks the talk — sometimes aggravating the comfortable or the powerful, but he is always willing to walk the walk.

George is generous in his support, not only for his doctoral students and post-docs, but for fellow colleagues and would-be colleagues as well. Regarding the latter, it is noteworthy that George agreed to split his chair when its endowment had reached a certain point of growth, in order to create a new endowed-chair opportunity directly instrumental in luring a world-class figure to ISyE in the early 2000s. Shortly after that, he also (and quite privately) reached into his chair’s funds and formed, along with a couple of other chaired faculty, a very competitive financial package that made possible an extended visit to the School by another particularly renowned figure. This man ultimately was recruited to join the permanent faculty of ISyE, something that would not have happened without that initial visit. The addition of both individuals alluded to, whose names appear earlier in this piece, not only solidified ISyE’s rank among the best programs in optimization anywhere, but as one of the two would remark, made it the “center of the universe.”

Spreading the Word

Especially among research universities, the coin of the realm in calibrating reputational standings is typically understood to be academic placement, that is, placement of a program’s Ph.D. graduates on university faculties and, to a lesser degree, in the most prestigious research labs. If one seeks to be credible in claiming a program’s stature, then the best way to validate that claim is to demonstrate that its top graduates are ultimately placed on the faculties of highly regarded programs. This is where the magnitude of George’s influence reveals itself in a fundamental way. A little history helps.

The first Ph.D. from ISyE was granted in 1961. Since that time, well over 600 have followed; historically, between 50 and 60 percent of these diplomates have sought academic positions upon graduation. In that regard, faculties at universities all over the country and around the globe have included graduates from ISyE — from large, research-intensive universities to small colleges primarily devoted to teaching. ISyE graduates take positions in engineering pro-

grams, business schools, mathematics, statistics, and computer science departments. Many of these positions are at strong institutions, including some that would be considered exceptionally strong; however, it wasn't until the late eighties that ISyE Ph.D.s began to legitimately compete for placements at programs of the first tier.

And this was just the beginning. Throughout the nineties and into the oughts, top ISyE graduates routinely began to get interviewed by the great programs, and to the point driving this story, many had a credible connection to George Nemhauser. They may have been directly influenced by George to consider an ISyE Ph.D. program (IE, OR, or ACO); they might have conducted their dissertation research under George's advisement; or they might have been recruited and mentored by one of the highly regarded faculty superstars, who were themselves motivated to join the faculty based on the academic and scholarly climate that was so profoundly impacted by George's presence. This is a highly relevant second-order effect that is particularly meaningful in validating his influence.

"1995 ISyE was a diverse, vibrant, and intellectually stimulating place. Heading this group was George Nemhauser, 'The Godfather,' if you will. He is remembered by many as ISyE's greatest champion, well-regarded for being supportive but stern. If Nemhauser said it, you knew that he had thought through each angle so that the School would continue to thrive. Above all, he had the students' admiration and respect. If I have had any modicum of success, it is in large part due to ISyE's unique environment; an environment that Nemhauser played a critical role in creating."

— Mark Lewis, Associate Dean of Diversity and Faculty Development and Professor, School of OR&IE, Cornell University

Accordingly, graduates from ISyE who fit the profile described above can be found, as this is written, on faculties or scientific staffs — some of which have more than one ISyE graduate — at the following universities or research institutions (note that included below are only graduates since 1987, and all but one of those since 1997):

- MIT (OR)
- University of California at Berkeley (IEOR)
- Northwestern University (IEMS)
- Northwestern University (Kellogg School of Management)
- University of Chicago (Booth School of Business)
- Harvard (Statistics)
- Mount Holyoke (Mathematics)
- Cornell University (OR&IE)
- Carnegie Mellon University (Tepper School of Business)
- University of Wisconsin-Madison (ISyE)
- University of Wisconsin-Madison (Statistics)
- University of Waterloo (Dept. of Combinatorics and Optimization)
- University of Chile (Mathematical Engineering, IE)

- Georgia Institute of Technology (ISyE)
- Centrum Wiskunde Informatica (CWI-Netherlands)
- Google
- GUROBI
- New York University (Stern School of Business)
- Thomas J. Watson Research Center (IBM)
- University of North Carolina-Chapel Hill (Dept. of Statistics and OR)

But it's not just faculty placement that has so profoundly changed in the Nemhauser era framed above. ISyE Ph.D. students began to not only compete for but also to win some of the most competitive and prestigious awards and prizes for work in OR and the mathematical sciences. Long dominated by graduates from the great programs that have been named here, Ph.D. students and graduates from ISyE began to have their day in the sun. Some of the most noteworthy prizes and honors are listed below, none of which had ever been won by an ISyE graduate prior to 1997, and all but three won from the early 2000s to the present (numbers in parentheses denote multiple winners):

- Optimization Society Student Paper Prize from INFORMS (3)
- Optimization Prize for Young Researchers from INFORMS (2)
- Quality/Statistics/Reliability Student Paper Award from INFORMS (4)
- Transportation Science Logistics Dissertation Award from INFORMS (5)
- George Dantzig Dissertation Award from INFORMS
- A. W. Tucker Prize from the Mathematical Optimization Society
- George Nicholson Student Paper Competition from INFORMS (4)
- Pritsker Doctoral Dissertation Award from IIE (2)
- Herman Goldstine Post-doctoral Fellowship-IBM (2)

The placements and awards enumerated above have all been realized in the span of George Nemhauser's residence on the ISyE faculty, and, as pointed out, many of the students whose achievements comprise the lists either worked directly with George, or with like-minded faculty in an academic and scholarly environment that was kicked into high gear by George when he arrived at ISyE in 1985. What is not debatable is that ISyE's stature and visibility among the premier programs — ones that, by whatever name, have historically been heavily OR-influenced — underwent a sea change traceable to the Chandler Chair that Mike Thomas used to bring George Nemhauser from Cornell.

Gadfly with a Conscience

As this is written, George Nemhauser will have been at Tech for 30 of his 55 years as an academic. It would seem that he found something here worth staying for. If asked why he has stuck around so long, there's a good chance that he'd point to what is probably unique about ISyE: The program may have shifted over the last 30 years toward bolstering its role and its reputation

in methodological research and scholarship, including the concomitant influence on graduate curricula, but it has done so while maintaining a healthy grip on the aim of doing genuinely good applications work. That's not a small thing to claim. And that it's true owes much to the perspective that George has brought to the program, as well as his energy in sustaining it.

Always a champion of rigor in basic research, he insists on similarly tough standards in relevant application settings. He has never been shy in calling out those who would be apologists for anything less. But even in deeper theoretical contexts, George conducts his work with a conscience. Proving hard theorems is important if quality scholarship is to be produced in our field, but it's no weakness to find it gratifying to see one's work put to use in the real world. That's not necessarily a universal belief system, but it seems to be so for George Nemhauser. What we have here in ISyE is a good-faith marriage between deep theory and credible applications — a healthy respect for both that can often join to form something that is stronger than either.

And, George puts his money (or more accurately, the money of his sponsors) where his mouth is. He takes a backseat to no one in promoting theoretical research, the introduction of mathematical rigor into graduate curricula, and the highest scholarly standards for the admission of doctoral students as well as in faculty promotion and tenure decisions; yet he openly courts funding that supports good applied research — research that often motivates even newer avenues for theoretical pursuits. Few in ISyE would guess that some of the largest dollar amounts of research funding in ISyE from industrial sources have been garnered under a principle investigator named Nemhauser. And, critically, the applications themselves exhibit incredible breadth and depth: everything from airline fleet routing to sports modeling and scheduling.

Validation

A betting person would probably claim that George Nemhauser would not have thought too long, nor too hard, about coming to the likes of ISyE in the late seventies, or even the early eighties. The smart betting person would know that he probably saw an opportunity here that appealed to his natural instincts to create and build; a sense that there was really something in ISyE to work with in 1985. The signs were certainly evident: something new and different could be built in ISyE with the emerging impact of a few exceptionally talented young faculty, in combination with a core cadre of strong senior people in key areas. What was lacking was coordination and scholarly leadership backed with a strong voice; nothing involving magic or alchemy, but a special talent that was right for the time and place. George Nemhauser was that person. It seems appropriate to end this story with some additional gifts from those who articulate the best form of support for that claim in their own words.

“One of the reasons I was attracted to ISyE is that the School has come to be highly regarded as a magnet for talented researchers, largely due to the direct or second-order influence of George Nemhauser. ISyE’s environment and enthusiasm for fundamental research have clearly made it a ‘go to’ destination for scholarly work.”

— Arkadi Nemirovski, John Hunter Chair and Professor, School of ISyE, Georgia Institute of Technology

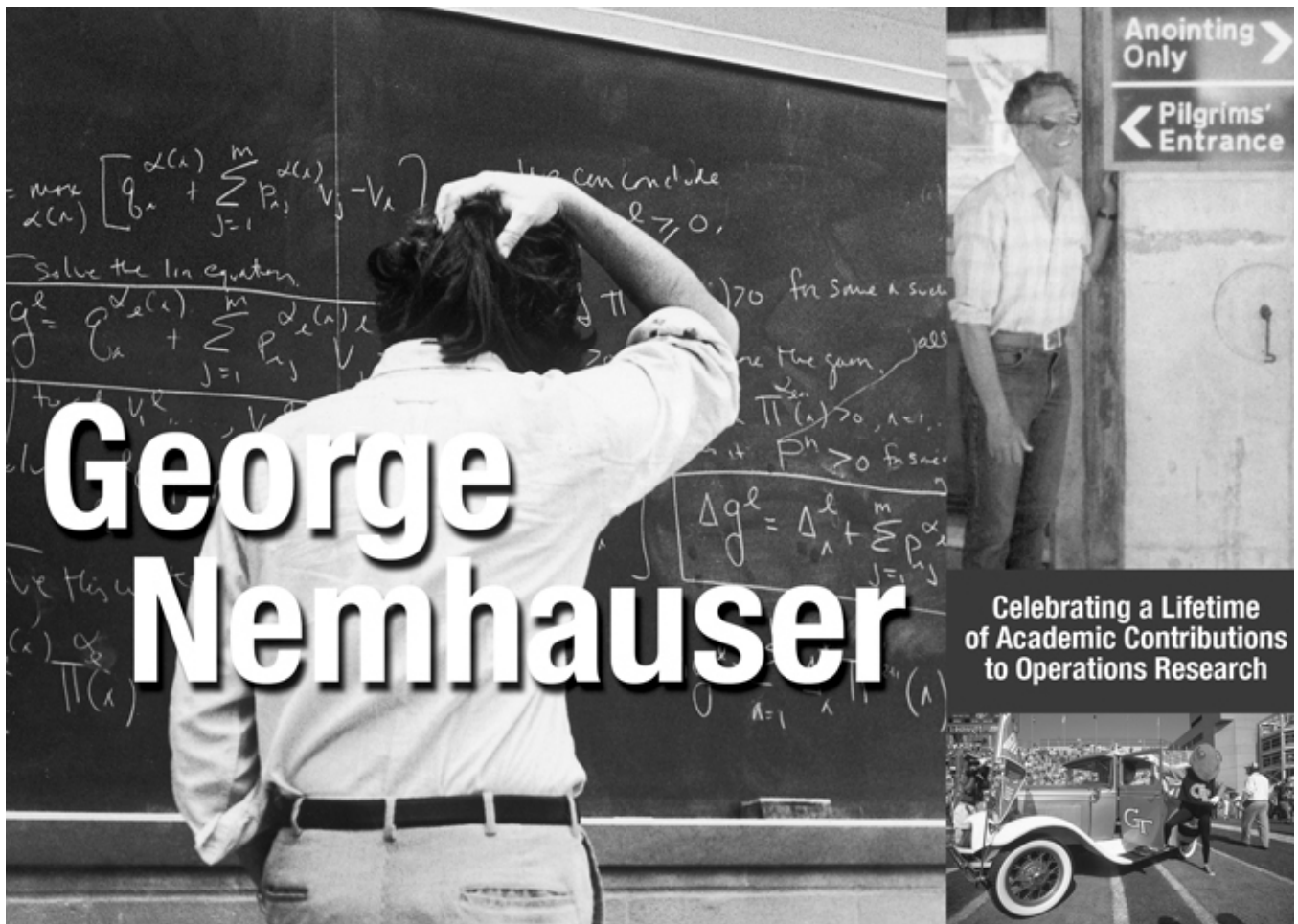
“I had the great opportunity to be a doctoral student at ISyE beginning 1983 through 1987. At that time, it was clear that ISyE had a fantastic set of young faculty, and I owe whatever subsequent success I have had with the interactions I had with them. But partway through my program, George Nemhauser arrived from Cornell, and he immediately changed the whole atmosphere and tenor of the program. The breadth and rigor he brought to research had a huge impact on my dissertation. The work I have continued with him and some of the other outstanding faculty he attracted to ISyE has had a lasting impact on my career.”

— Mike Trick, Associate Dean and Professor, Tepper College of Business, Carnegie Mellon University

“George has an uncompromising insistence on quality, which is in my observation the single most important reason for ISyE to retain its top, world-class ranking. I am so glad that he is receiving the Class of 1934 Award. It is a great (and belated) honor that befits his great contributions to this institution.”

— Jeff Wu, Coca-Cola Chair and Professor, School of ISyE, Georgia Institute of Technology; member, National Academy of Engineering

Q.E.D.



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