special feature

perspective on

a transient lifetime in photochemistry

an interview with Anthony Trozzolo

Anthony Trozzolo is recognized for "outstanding contributions to the science of photochemistry".

The Gregory and Freda Halpern Award in Photochemistry of the New York Academy of Sciences

Courtesy of Anthony Trozzolo

The late Thomas Kuhn, author of that 1962 classic in the philosophy of science, *The Structure of Scientific Revolutions*, argued that science does not advance through a linear accumulation of new knowledge. Instead, it undergoes periodic revolutions—"paradigm shifts," he called them—that abruptly transform scientific inquiry within a particular field.

What fosters these shifts? Many of us have been eyewitnesses to one example. It was the late Richard E. Smalley's skillful use of the forum provided by a Nobel Prize (http://pubs.acs.org/cen/coverstory/84/8441cover.html) to shepheard emergence of nanoscience and nanotechnology as a new scientific discipline. A seminal conference or landmark lecture also may help foster the consolidation of an emerging field of science.

The first Gordon Research Conference on Organic Photochemistry had such an effect, according to some pioneers in this now-robust field. They regard that 1964 conference as *the* seminal event in organic photochemistry's emergence as a self-standing discipline in chemistry. *The Spectrum* is delighted for the opportunity to chat in this edition with the individual who organized and chaired that first conference and played such a memorable role in the maturation of organic photochemistry.

In this interview, however, Anthony M. Trozzolo identifies an earlier conference as the seminal event in organic photochemistry's emergence. Trozzolo's pick is an ACS organic chemistry symposium at Indiana University in which Howard Zimmerman and George Hammond galvanized attendees with interpretations for a variety of organic phototransformations.

Neither of those giants in the field was present at the first Gordon Conference. Trozzolo explains the reason, discusses how photochemistry and its practitioners have changed over the years, describes the evolution of his own research, and offers insights and advice for younger scientists and scientists facing decisions about retirement. Readers will even learn why Trozzolo's most requested talk on the American Chemical Society (ACS) lecture circuit is a "lot of Bologna."

Tony Trozzolo is the Charles L. Huisking Professor Emeritus of Chemistry at the University of Notre Dame. He received his B.S. degree in chemistry from the Illinois Institute of Technology in 1950 and the M.S. and Ph.D. degrees from the University of Chicago in 1957 and 1960, respectively. In 1959, he became a Member of the Technical Staff at the Bell Telephone Laboratories in Murray Hill, New Jersey, where he remained until 1975 when he became the first Huisking Professor at Notre Dame.

Trozzolo's research has focused on the creation and detection of reactive intermediates. The methodology often involves low-temperature photochemistry or solid-state photochemistry. Among the intermediates studied are carbenes, azomethine ylides (from aziridines), carbonyl ylides (from oxiranes), and nitrenes (from azides). The detection techniques include e.p.r. spectroscopy, laser spectroscopy, and optical spectroscopy. Trozzolo also has conducted research in the following fields: photostabilization of polymers, dye lasers, singlet molecular oxygen, charge-transfer complexes, molecular magnets, and superconducting intercalation complexes.

That work resulted in more than 90 research articles and 31 U.S. and foreign patents. Noted as a dynamic lecturer, Tony has delivered over 300 invited lectures at universities, international meetings, ACS symposia, and industrial laboratories. His numerous awards and honors (www.nd.edu/~atrozzol/) include two perhaps unique among photochemical scientists. In 1997, Tony was named "Honorary Citizen" of Castrolibero, Italy, and selected as the first recipient of the Pietro Bucci Prize co-sponsored by the Italian Chemical Society and the University of Calabria. He was also the fourth awardee (after Nick Turro, Orville Chapman, and Howard Zimmerman) of the Gregory and Freda Halpern Award in Photochemistry of the New York Academy of Sciences in 1980.

***The Spectrum:* What led you to organize that first Gordon Research Conference on Organic**

Photochemistry in 1964? Take us back to the early 1960s and describe what was happening in the lab and the marketplace to create the need for such a conference.

Trozzolo: In 1962, Professor W. George Parks, the Director of the Gordon Research Conferences, published a notice in *Science* soliciting proposals for new Gordon Conferences. I sent in a proposal citing the fact there was no conference being held on a continuing basis on organic photochemistry and that the subject was developing at a very rapid rate. Although the proposal was not acted upon in 1962, a chance meeting at a luncheon (1963 Metro Regional Meeting in Newark) with Cecil L. Brown, who was on the Board of Trustees of the Gordon Conferences, gave me the opportunity to reinforce the case for a conference, and the Gordon Conference on Organic Photochemistry was approved to be held for the first time in 1964 at Tilton School in New Hampshire. Coincidentally, an International Conference on Photochemistry (honoring W. A. Noyes) was held in Rochester in March 1963 and I had the opportunity to meet many of the leading photochemists, such as Ronald Norrish, George Porter, Albert Weller, Egbert Havinga, Gunther Schenck and others. Attendance at this meeting proved invaluable in contacting prospective speakers for the Gordon Conference.

Group photo of the 1964 Gordon Conference on Organic Photochemistry.

Courtesy of Gordon Research Conferences

***The Spectrum:* So you assembled the leaders in the field. Who was there?**

Trozzolo: Since this was the first Gordon Conference on Organic Photochemistry, I had the luxury of choosing speakers from the entire field since no one had spoken before. In 1963, photochemistry studies were largely focused on the use of energy transfer in controlling the excited-state chemistry although charge-transfer quenching was being studied by Albert Weller and others. The program of the first Gordon Research Conference was arranged to show this progression. The first speakers—George Porter and N. C. Yang—stressed energy transfer and differences in reactivity of singlet and triplet excited states while the Friday speakers—Sean McGlynn and Albert Weller—concentrated on charge-transfer processes. Other speakers included Orville Chapman, Gary Griffin, Rudolf Wolgast (pinch-hitting for Gunther Schenck), Harry Gunning, James McNesby, Ted Ullman, Robert Livingston, Ed Wasserman, and R. Srinivasan. With this core of thirteen speakers, we had plenty of time for short contributed talks and informal discussion.

***The Spectrum:* How many were in attendance?**

Trozzolo: There were 120 conferees, 73 of whom came from 42 different industrial labs (How times have changed!). Included in the 36 academic conferees (nine of whom were speakers), were three young postdocs from Harvard about to launch brilliant academic careers who drove together to the Conference from Cambridge, namely, Nick Turro, Doug Neckers and Jacques Streith. In later years when I served on the Screening and Scheduling Committee and the Board of Trustees of the Gordon Research Conferences, I always advocated the inclusion of postdocs and even graduate students as participants in the Conferences. Paul Kropp and the late Don Arnold were in industrial labs in 1964, but later, both became academicians and both served as Chairman of the Conference in subsequent years. Other young academicians in attendance included David Hercules, Sally and Frank Mallory, Al Padwa, David Schuster, Peter Borrell, Peter Leermakers, Tony Testa, Colin Steel, and Ron Sauers. In addition to Ed Wasserman, Bell Labs colleagues (who all have played a role in the development of photochemistry) at the Conference included Ed Chandross, Adam Heller, and Larry Snyder.

***The Spectrum:* What did they discuss, what ideas emerged, what do you recall most about the sessions?**

Trozzolo: The topics in the invited talks included: photochemistry of carbonyl compounds, photoisomerizations, photochromism, photolysis of hydrocarbons, epr of triplet ground-state molecules, photoreactions of olefins catalyzed by pi-complexes, charge-transfer in excited states, photocleavage of episulfides, and quenching mechanisms (electron transfer vs. energy transfer). The discussion periods always seemed to go overtime. This was a time for us to get to know each other and to find out what other interesting systems were being studied and what mechanistic concepts were being applied or in need of refinement. My guess is that the impact of the conference was really felt only after we returned to our respective institutions and had time to savor what had transpired in the week at Tilton School.

George Porter and Nick Turro at the 1994 IUPAC Symposium on Photochemistry in Prague when Nick received the Porter Medal.

Courtesy of Anthony Trozzolo

***The Spectrum:* Some of the attendees look back on this conference and say that it was the seminal event that solidified organic photochemistry as a self-standing field in chemistry. Was it the conference content, or the fact that organic photochemistry had reached the point where a Gordon Conference was warranted, or both or what?**

Trozzolo: I am happy to hear that some attendees feel that it was a seminal event, but for me another event took place in 1961 which further increased our interest in photochemistry and its implications in mechanistic organic chemistry. The 19th Organic Chemistry Symposium took place at Indiana University and two of the speakers, Howard Zimmerman and George Hammond, presented their respective studies and interpretations for a variety of organic phototransformations. It was evident that mechanistic organic photochemistry was becoming more rational and excited-state descriptions (largely obtained from the detailed studies of spectroscopists) could be used along with the concept of energy transfer (from photosensitization studies) to explain many photochemical reactions. We had reached a point where it was clear that enough was going on in the field of photochemistry to warrant bringing together that community and the Gordon Conference structure with its great opportunity for informal discussion seemed a natural solution. Professor W. George Parks' *Science* ad mentioned earlier provided the incentive to follow the third line in Rabbi Hillel's dictum: "*If not now, when*?"

***The Spectrum:* Those attendees still remember George Porter's talk. By one account, Porter barely mentioned flash photolysis for which he would win the Nobel Prize a few years later. What do you recall about George Porter's presentation and about George himself?**

Trozzolo: Porter's talk was mainly about the reactivity of excited states of carbonyl compounds and the electronic transitions which created these as well as the differences in reactivity of the singlet and triplet states produced. He had a mechanical model which illustrated the transition and the movement of the electron changing its orbital location. As I mentioned earlier, I had met George Porter on two occasions in 1963, in March at the Noyes Symposium in Rochester, and in July at the 6th International Symposium on Free Radicals held at Cambridge, England. As a pioneer in the technique of matrix-isolation, he was particularly interested in our use of the technique at Bell Labs done in collaboration with Ed Wasserman, Bob Murray, Gerry Smolinsky, and Bill Yager in which the triplet ground-state structure of a variety of carbenes and nitrenes had been determined. I was pleased to learn in early 1964, that he would not only be able to speak at the Conference, but that he was bringing his wife, Stella, and their two young sons, John and Andrew.

***The Spectrum:* Were children allowed on site in those days?**

Trozzolo: At that time, Gordon Conference regulations prevented children under the age of twelve from being housed at the Conference site, and so we arranged for the family to stay at Webster Lodge on Webster Lake just a few miles away from Tilton School. Porter later wrote that it was a great time for the family. In 1967, George and I were both scheduled to present plenary lectures at the 8th International Symposium on Free Radicals in Akademgorodok, Siberia. I

was looking forward to seeing him there, because one of his graduate students, Willie Gibbons, had come to Bell Labs to help me elucidate the electronic spectra of aryl carbenes, and we had found a great similarity between our spectra and the spectra of the benzyl radicals which Porter had produced by flash photolysis. Unfortunately, illness kept him from attending. We met periodically at IUPAC symposia, and in 1986, the University of Notre Dame awarded him an honorary Doctor of Science degree.

***The Spectrum*: Was there any sense that George was headed for a Nobel Prize?**

Trozzolo: In 1964, it was clear that matrix-isolation techniques had permitted the characterization of reactive intermediates by stopping them "dead in their tracks" and allowing spectroscopic measurements. Porter and Norrish, in developing flash photolysis, made it possible to generate a large population of the reactive intermediate over a very short time, and thus do spectroscopic measurements on the unencumbered intermediates. It became evident that this would be part of the wave of the future as lasers became available and in 1967, the Fifth Nobel Symposium on "Fast Reactions and Primary Processes in Chemical Kinetics" was held in Sweden featuring Manfred Eigen, Ronald Norrish, and George Porter. The three shared the Nobel Prize in Chemistry that December.

***The Spectrum*: Why were George Hammond and Howard Zimmerman missing from that first conference?**

Trozzolo: One of the first persons that I invited to lecture at that first Gordon Conference was George Hammond. However, just shortly before that time, George had suffered a fainting spell at the 1963 fall ACS meeting in New York and for health reasons did not feel that he could accept. However, he did like the idea of a conference on photochemistry, and having an international perspective, became the organizer of the first IUPAC Symposium on Photochemistry which was held in Strasbourg in 1964. These two series of conferences, along with the International Conference on Photochemistry (organized mainly by physical chemists) and, more recently, the I-APS Conferences, have provided the main forums for the photochemist. I also invited Howard, but George Hammond had invited him to the IUPAC Symposium. My recollection is that Howard also was going to spend some time in Europe visiting friends and former colleagues, thereby conflicting with GRC. I should hasten to add that both George and Howard attended the second Gordon Conference (chaired by the late Orville Chapman) in 1965, and Howard has attended most of the Conferences since 1965.

***The Spectrum*: So you've attended every Gordon Photochemistry Conference since then?**

Trozzolo: No, I missed the 1967 and 1975 Conferences. In 1967, I was invited to present a plenary lecture at the 8th International Symposium on Free Radicals which was being held in Akademgorodok (near Novosibirsk) in Siberia at the same time as the Gordon Conference. It was a great opportunity to visit the "Science City" that I had heard so much about as well as scientists in Moscow and Leningrad. In fact, due to the political situation at that time, it took about three months before I got approval to go from Bell Labs. I missed the 1975 Conference because our move to Notre Dame coincided with the date of the Conference. The 1975 Conference was the last held at Tilton School, as we were moved to the more rustic environment of Proctor Academy for the next eight conferences.

Past chairs and future chair in attendance at the 2005 Gordon Conference on Photochemistry. Standing (left-to-right): Gary Schuster (1989), Paul Kropp (1971), Laren Tolbert (2003), Linda Johnston (2007), David Whitten (1997), and Trozzolo (1964). Seated: Rich Givens (2001), V. Ramamurthy (2005), Kirk Schanze (2005), and Nick Turro (1973).

Courtesy of Dolly Trozzolo

***The Spectrum*: What changes have you noticed in the participants, their presentations, their outlooks as photochemistry matured as a science and younger scientists entered the field?**

Trozzolo: There have been a number of major changes in the Conference since 1964. The biggest change has been the large decrease in industrial conferees so that the last few conferences have only had a handful of industrial participants as compared with 73 at the original Conference. The size of the Conference peaked in 1981 with 145 conferees with the last few conferences averaging slightly above 100. The other major changes, which I consider positives, have been: (1) greater number of foreign conferees (~40%) giving the Conference an international character; (2) greater number of women (The chair of the 2007 Conference is Linda Johnston); and (3) the greater participation by postdocs and graduate students.

With the increased activity in the field of photochemistry, the program has also changed so that from the 13 invited speakers in 1964, we had 34 invited speakers at the 2005 conference, which, in addition, had two poster sessions (posters were not permitted in 1964). The 2005 Conference had a relatively large number of graduate students and postdocs, who as first-time attendees obviously enjoyed the informal interacton with an international group of their peers and affirmed the vitality of the subject. Everyone seemed to participate in the discussions, whether in the lectures or the poster sessions. It is particularly satisfying to me to see the younger scientists of earlier conferences progress in their careers and contribute to the field as photochemistry interacts increasingly with other areas such as materials research, nanotechnology, photobiology, and renewable energy.

***The Spectrum*: You have the reputation as a dynamic, compelling lecturer. Doug Neckers remembers one of your lectures—at the University of Kansas when you were with Bell Labs—despite the passing of almost 40 years. It dealt with azo compound isomerizations. What are the secrets to leaving that kind of impression? What advice can you offer students and younger scientists about delivering an effective talk?**

Trozzolo: I'm flattered that Doug remembers. Actually, the seminar that Doug referred to was in 1963, when he was a graduate student at Kansas and his advisor, Earl Huyser, invited me to give a talk on our recent results on photodecompositions of bis-diazo compounds which produce di-carbenes and intermediates with interesting structures (Since Earl and I both had Wilbert "Bill" Urry as our graduate advisor at the University of Chicago, I can claim Doug as a "scholastic nephew"). How does one give a memorable lecture? I believe that there are several features involved. Since the primary purpose of the lecture is to communicate, it follows that the most important ingredient is content; in other words, have something to say, a story to tell. I have seen talks which were beautiful powerpoint presentations but had little content, and one comes away disappointed.

The second ingredient is to be enthusiastic about having the opportunity to relate your story, particularly when it involves novel and unexpected results. It is also important that you introduce the subject of the talk in a manner in which you and the audience have the same "universe of discourse." Often it is possible to present a talk as a "detective story" with its mystery or unsolved problem; the methodology is introduced, there are a few unexpected turns, and the mystery is solved. Equally important is the effective use of visual aids, whether blackboard, slides, or demonstrations. Ever since my teens, magic has continued to be one of my hobbies, and I believe that performing magic tricks can make you a better lecturer. In one of my lectures on photochromic substances, I produce a poster which appears to be blank. When a "black light" is passed over the poster, the message "It's not magic, it's photochemistry" suddenly appears. It's also the message of Hammond and Zimmerman at the 1961 Organic Symposium and that of the first Gordon Conference in 1964.

Panelists in a seminar, Origins of Photochemistry in Italy, held April 1993 at the Casa Italiana at Columbia University. Left-to-right: Heinz Roth, Maristella Lorch (Director of the Casa Italiana), Angelo Lamola, Nick Turro, and Trozzolo.

Courtesy of Anthony Trozzolo

***The Spectrum*: What first sparked your interest in science during childhood? When did it happen? Were there mentors or role models in elementary school or high school, for instance?**

Trozzolo: My interest in science probably began in the late 1930s when the Museum of Science and Industry opened its west wing. My older brother, Mario, and I spent many

Saturdays visiting the museums of Chicago and what we found particularly appealing about the Museum of Science and Industry (it also was called the Rosenwald Museum) was the "hands-on" exhibits. I liked the colors produced by polarizing filters and wondered how the color was created. There was a "Fire Show" each October which illustrated various forms of combustion, and an exhibit on the hydrolysis of water. I was attracted to chemistry because of its sensual effects such as color changes, white precipitates, crystals of various shapes, etc. Although most of my teachers in both elementary and high school were very dedicated (their early careers began in the Great Depression), several stand out.

My second grade teacher, Miss Margaret Oliphant, taught me the values of good penmanship, neatness, and responsibility. She also double-promoted me into the advanced half of third grade. In high school, I had Mrs. Anatasia Springer for most of my math courses. In addition to being a great teacher of mathematics, she was the faculty sponsor of the Slide Rule and Math Club and when the Club met after school hours, she personally helped me to empirically derive by induction the formulas for permutations and combinations. My Italian teacher, Mrs. Antenisca Nardi, who also had taught my older brothers, strongly encouraged us to continue our education in college, and even visited my parents to stress this point. My chemistry teacher, Francis C. Coulson, reinforced my interest in chemistry. He said (in jest, I assume): "Stay in chemistry, and you'll win a Nobel Prize."

***The Spectrum*: Well, maybe you came closer than you know.**

Trozzolo: The closest that I came to fulfilling that prophesy was when Doug Neckers, my wife and I were in the audience at the Award Ceremony to see Roald Hoffmann and the late Kenichi Fukui receive their Nobel Prize in 1981, but we're still waiting for the phone call from Stockholm.

***The Spectrum*: Did you conduct research as an undergraduate?**

Trozzolo: My undergraduate research advisor at Illinois Tech, Eugene Lieber, provided me with the opportunity to present our results at the September 1949 ACS Meeting in Atlantic City under the title "The Hydroxylamine Number Application to the Identification of Ketones." He was also the one who introduced me to the methodology of doing research. That research also led to my first publication in the June 1950 issue of *Analytical Chemistry*. At the University of Chicago, my advisor, Wilbert H. Urry, convinced me to go back to graduate school in 1956 (even though I was married and had a son) and provided a Union Carbide Fellowship which was specifically given to married students.

At this point, I think that it's important to acknowledge the financial aid which was provided to me both in the form of undergraduate scholarships and Atomic Energy Commission and National Science Foundation Graduate Fellowships as well as the aforementioned Union Carbide Fellowship. Without those sources of support it would have been difficult if not impossible to pursue my studies and research. The presence of role models continued at Bell Labs as we kiddingly referred to our in-house collaborations as "being each other's postdoc." These collaborations widened greatly our research horizons.

***The Spectrum*: Tell us about how you found your way to Bell Labs and then to Notre Dame.**

Trozzolo: My interest in photochemistry actually began as an interest in the spectroscopy of charge-transfer complexes during the three years (1953-56) that I spent at Armour Research Foundation (now IIT Research Institute) working on a variety of contract research projects. I had always had a fascination for generating colors by chemical reactions and the mere mixing of trinitrobenzene and anthracene in solution to generate an orange color provided an excellent example worthy of explanation. The classic Mulliken papers on charge-transfer had just appeared and stimulated many studies in this particular area of research. My interest in solid-state organic chemistry also began during this period under the tutelage of the late Walter McCrone, who was already at that time a microscopist of international repute.

When I returned to the University of Chicago in 1956 to pursue my doctoral research with Professor Wilbert H. Urry, my studies initially concentrated on the photochemical decomposition of diazomethane in polyhalomethanes (a reaction which has had very interesting mechanistic aspects), but ultimately became concerned with bimolecular initiation of free-radical reactions. It was near the end of this period (1958) that I became aware that Bell Laboratories was going to add a few organic chemists to its technical staff in Murray Hill. I was fortunate enough to be one of the five additions in 1959 to join Ed Wasserman (who had arrived a few years earlier from Harvard) in the department headed by Field H. Winslow.

The years that followed were to be scientifically rewarding for each of the six (Ed Chandross, Gerry Smolinsky, Dick (Paul) Story, Bob Murray, Ed Wasserman and me),

and later, Heinz Roth, as we launched our individual careers in physical organic chemistry, and in particular, the creation, detection, and characterization of reactive intermediates, such as carbenes, carbocations, and nitrenes. In many of these studies, the photochemical decomposition of a suitable precursor was the preferred method for generating the reactive intermediate. Also, I would be remiss if I did not acknowledge the encouragement of the Bell Labs administration, particularly that of our department head, Field "Stretch" Winslow, a pioneer in polymer chemistry, who became the founding Editor of *Macromolecules* in 1968. Stretch celebrated his 90th birthday last June.

Field (Stretch) Winslow's 80th birthday in 1996. Left-to-right: Trozzolo, Stretch, Ed Chandross, Ed Wasserman, and Gerry Smolinsky.

Courtesy of Anthony Trozzolo

***The Spectrum*: And your path to South Bend, Indiana?**

Trozzolo: The path to Notre Dame probably began (although I didn't realize it at the time) in 1971 when Nick Turro invited Angelo Lamola and me to give his photochemistry course at Columbia since he was going to be on leave (as it turned out, although he was on leave, he stayed at Columbia during this period). It was my first teaching experience since my undergraduate days at Illinois Tech (I had been an AEC and NSF Fellow at Chicago, and these fellowships carried no teaching responsibilities) and I enjoyed it very much except on two occasions. The first exception was when I had to lecture on carbonyl photochemistry with Nick Turro in the front row (he came to all the lectures) and the second was when I had to give a magic show with Koji Nakanishi in the audience. Talk about carrying coals to Newcastle!

In the following year, I was invited to give a series of Peter C. Reilly Lectures at the University of Notre Dame. The title of the series was "Creation and Detection of Excited-State Intermediates" and the lectures dealt with photochromism, singlet oxygen, and dye lasers. Although I had been raised in nearby Chicago and did not leave until the completion of my doctoral research, and had been a life-long Notre Dame football fan, I had never visited the University before my lectures in October 1972. In 1974, I was offered the Huisking Professorship in Chemistry at Notre Dame and a year later in 1975, I joined the Department of Chemistry and became a member of the Radiation Research Laboratory as well. It was not easy to leave Bell Labs' superb research environment and my colleagues there, many of whom had international reputations as outstanding researchers, but in retrospect, it was the right thing to do at that time.

***The Spectrum*: What kept you at Notre Dame?**

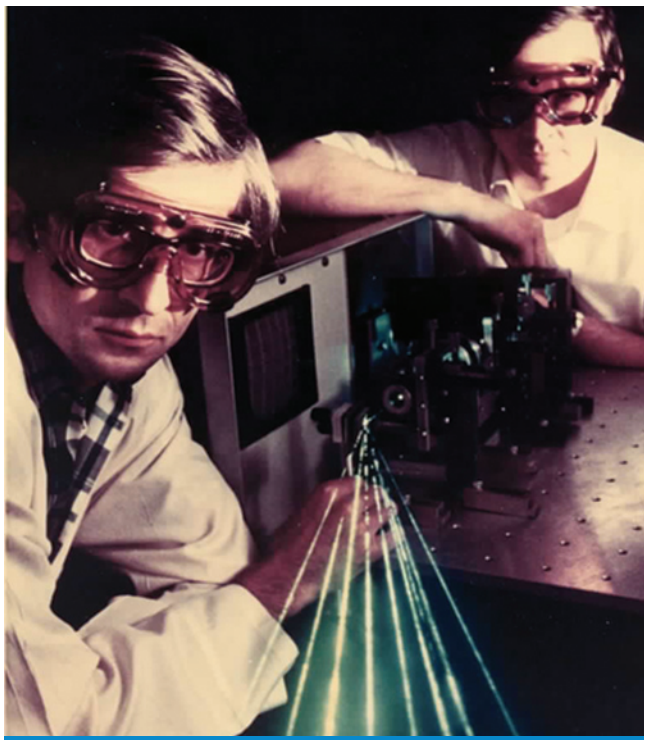
Trozzolo: Even before I arrived at Notre Dame, my career began to take on additional facets, involving more administrative functions, such as the Associate Editorship of the *Journal of the American Chemical Society* and the Editorship of *Chemical Reviews* (One can point out that the last three Editors of *Chemical Reviews*, Harold Hart, myself, and the current Editor, Josef Michl, have all had photochemical research interests) and many committee and Board assignments both in the ACS and in the Gordon Research Conferences. Also, being the early occupant of an endowed chair at Notre Dame made me vulnerable to frequent assignments on various committees such as search committees for additional chair positions which were then being established. While these assignments were time-consuming, I felt that I was participating actively in the development of the University.

In addition, the presence of many congenial colleagues, both in the Department and throughout the University, and many excellent students has made the last thirty-one years quite intellectually satisfying and six Notre Dame degrees for my children attest to the nonscientific gratification enjoyed during this period. When our children were undergraduates at Notre Dame, I would often be pleasantly surprised by encountering them on campus on their way to a class (They all lived on campus even though our home was three miles away). But the main reason for remaining is the same as the reason that I came, namely, that as Kingman Brewster, then president of Yale, said in his preface to Father Theodore Hesburgh's book *The Humane Imperative: "Yet because of the religious heritage of the place, Notre Dame is one*

of the few universities I know that reminds the visitor, as well as those who work and study there, that learning at heart is a morally motivated act."

***The Spectrum*: How did your research interests change over the years?**

Trozzolo: My undergraduate research at IIT involved using the oximation of ketones as an quantitative analytical technique for their identification. At Armour Research Foundation I became interested in microscopic techniques for studying a variety of organic solid-state problems, including charge-transfer complexes. My doctoral research involved thermal bimolecular initiation of free radical reactions. At Bell Labs, the general theme became the creation and detection of reactive intermediates such as carbenes, dicarbenes, ground-state triplet and quintet species, singlet molecular oxygen. The "creation" step usually involved the photolysis of a suitable precursor, and the detection and characterization usually involved a spectroscopic technique such as electron spin resonance, absorption or emission spectroscopy, chemically induced-dynamic nuclear polarization (CIDNP). I also became interested in the oxidative photodegradation of polymers which led to some interesting excursions into photobiology in collaboration with Angelo Lamola and Susan Fahrenholtz.



Exciplex dye laser developed with Charles V. Shank and Andrew Dienes of Bell Labs in 1970. Chuck is changing the wavelength and Andrew is changing the spatial distribution, all happening during the photograph exposure time.

Courtesy of Bell Labs

Another collaboration with Hollis Wickman led (serendipitously) to the synthesis and characterization of the first molecular magnet, the pentacoordinate bis-(N,N-diethyld ithiocarbamato)iron III chloride, which, in addition to its novel magnetic property, had a spin quartet ground state. Collaboration with Chuck Shank and Andrew Dienes led to the "exciplex" laser with very wide tunability range in the visible based on simple notion of differences in pK_a between ground state and excited state of hydroxy-coumarin dyes. One of the interesting features of these studies was that one could time-resolve the stimulated emission from the various excited states and thus get a time-profile of the excited-state proton transfers.

***The Spectrum*: Some of your work was in photochromism?**

Trozzolo: Our interest in photochromism actually was the spin-off of a collaboration with the late Gary Griffin who was interested in the photolysis of oxiranes as a source of carbenes. Low-temperature studies showed that a colored intermediate was being formed in addition to the carbene. It turned out to be the carbonyl ylide.

By turning our attention to aziridines, Thap DoMinh and I were able to generate colored azomethine ylides, which were stable at room temperature for many hours. These turned out to provide for some very useful lecture demonstrations of the ability to control lifetimes of the colored species (azomethine ylide) by making use of substituents, solid-state environment, and, of course, orbital-symmetry conservation rules. At Notre Dame, Tom Leslie was able to get fluid solution lifetimes of the ylides by laser kinetic spectroscopy. Some recent interest has been in the nonlinear optical properties of the photochromic aziridines. Along the way, I managed to do some applied research, usually as the outgrowth of other studies, so that patents have been issued in the area of dye lasers, photochromic lenses, and copper deactivators (to stabilize polyethylene against autooxidation).

***The Spectrum*: How did you become Huisking Professor of Chemistry?**

Trozzolo: When I was first contacted about a position at Notre Dame in 1974, I did not know that it was about an endowed chair. My visit as Reilly Lecturer in 1972 had left a very favorable impression about the hopes and aspirations of the Department of Chemistry. After spending a few days on campus meeting with members of the Department, the Administration, and the Radiation Laboratory, my return home to Murray Hill, New Jersey, was the beginning of an emotional roller-coaster ride for my family and me.

When we finally accepted the Notre Dame offer and made the move in 1975, we were welcomed into the Notre Dame community in grand style. My formal inauguration involved an installation ceremony, inaugural lecture, a Mass honoring Charles and Catherine Huisking, a dinner honoring the Huisking family, and—a football game (Notre Dame vs. Georgia Tech) with 50-yard-line seats. Although we didn't realize it at the time, that game was to become memorialized in the movie "Rudy," as the game in which Rudy Ruettiger, a Notre Dame senior, finally gets to play.

***The Spectrum*: How useful are review articles? Do review articles get enough attention? Should there be more reviews?**

Trozzolo: In 1980, as I began my fourth year as Editor of *Chemical Reviews*, I wrote an editorial in which I pointed out the virtues of the scholarly art of writing review articles, one of which was its value "of integrating and committing to posterity the knowledge and understanding that have been accumulated with much human effort." This rings as true today as it did in 1980, perhaps, even more so. In view of the ever-increasing amount of research studies and publications, there is a continual need to upgrade and organize this new knowledge.

An indication of the stature and usefulness of reviews is provided by recent studies on citation data of publications which shows that review journals have higher impact factors (impact factor is the average number of citations per source item) than other journals and that *Chemical Reviews* consistently has had the highest impact factor of any chemical journal. Whether we need more reviews is answered by saying that we are always in need of good reviews. By that I mean reviews which are comprehensive, but not merely catalogs of data. They need to be critical, with the hope of being seminal in setting new paradigms for the subject. In my short essay at the beginning of the 100th volume of *Chemical Reviews* in 2000, I gave a few examples of reviews published in that journal which have fulfilled those expectations.

***The Spectrum*: Any advice for the sizable number of photochemical scientists who are nearing retirement age? How can they avoid being eclipsed by younger faculty, or make the best decision on whether to retire or work?**

Trozzolo: My advice is aimed at academic scientists since the retirement of industrial scientists in recent years has often been caused by economic factors beyond their control. My advice is this: If you are happy in what you are doing and have the financial support to continue your research, don't retire. If, however, there are certain aspects of your life, people and places to visit, hobbies, etc., that haven't received as much attention during your career as you would like, then retirement has its attraction. For six years after I became emeritus, I was the Assistant Dean of the College of Science and taught a course on "Seeing the Light in Science" which I designed "from scratch." It may be possible to arrange a similar gradual change from a full-time position. I also wouldn't worry about being eclipsed by the younger faculty. It's going to happen, sooner or later. That's actually one of the great satisfactions of the academic career. To see your younger colleagues (whom you had a hand in choosing) succeed in their fields.

***The Spectrum*: What pursuits keep you engaged today?**

Trozzolo: My current activities these days divide up into three groups: institutional, professional, and family. At Notre Dame, I currently serve on the Faculty Senate representing the emeriti faculty. This gives me an opportunity to be "in the loop" regarding University affairs, and to try to insure that the emeriti continue to be regarded as a valuable resource for the University community. I am still actively involved with the ACS Local Section Speaker Service. Of my menu of five different lectures, the one most often chosen by the Sections is: "Origins of Modern Photochemistry in Italy—A Lot of Bologna."

I have continued to be active with the Gordon Research Conferences, attending at least one conference a year since I became emeritus. The year 2006 is a special one for the Conferences, marking their 75th Anniversary. The past year has been eventful for my wife, Dolly, and me as we celebrated an event arranged by our children, our 50th wedding anniversary, and had a new house constructed so that we, in principle, could "down-size." Six months after we moved in, the down-sizing still continues.

***The Spectrum*: Is there any one question you wish we had asked?**

Trozzolo: The question would be: What role did your wife, Dolly, play in your career? And the answer: Dolly has been a constant source of support and encouragement throughout the 51 years of our marriage. From the sacrifices of graduate school when our family was growing and our financial status was barely viable to the absences caused by my increased

At the 1993 Physical Organic Chemistry Gordon Conference. Left-to-right: Tony, Dolly Trozzolo, and Alex Cruickshank (Director Emeritus of the Gordon Research Conferences).

Courtesy of Anthony Trozzolo

travel due to professional commitments, she was the mainstay of our family's welfare. Once the children were older, she began to accompany me to meetings and on speaking tours, and has been to so many conferences on photochemistry that she has a pretty good grasp of the vocabulary.

At Gordon Conferences, she urges first-time conferees to "network" and get to know the leaders in the field. Even Alex Cruickshank, long-time Director of the Gordon Conferences, once kidded her about being an honorary conferee. When Father Theodore Hesburgh, while celebrating our 50th Anniversary Mass at Notre Dame last year, was giving his homily about marriage, he mentioned: "The Italians have an expression to define 'love.' It's '*ti voglio bene*' which literally means 'I wish you well'." Dolly has been living that definition and it has reflected on my career.

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