

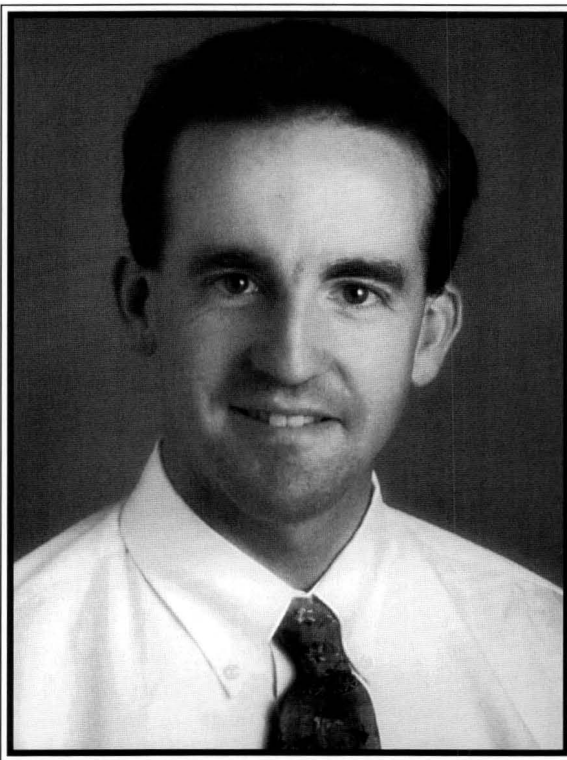
Frank Doyle III

Reflections from his friends and colleagues

Edgar Allan Poe is rumored to have placed a curse on the city of Newark, Delaware, after a bad experience in a local watering hole. The curse: "Anyone who is in Newark cannot wait to leave, and when you are gone, you are homesick for Newark." This legend has special significance for Frank Doyle, who grew up in Newark, left for college and graduate school, and after sixteen years has returned to teach at the University of Delaware.

The origins of Frank's interest in chemical engineering can be traced to Newark. First, his father is a chemical engineer (he is the Information Technology Manager at the nearby Motiva Refinery), which seems to have influenced both Frank and his younger brother Patrick. Second, he was drawn to chemistry and mathematics from as early in his education as the eighth grade. He recalls attending classes on Saturday mornings to learn algebra under the watchful eye of Sister Mary Alice. Frank recalls, "The nuns at my high school almost talked me out of chemical engineering—however, the alternative they had in mind was the priesthood."

Although Frank grew up in the shadow of the top-ranked chemical engineering program at the University of Delaware, he chose to go out of state to Princeton University for his undergraduate training. His decision was partly based on



the proximity of his parents' house to the campus, and partly on his desire to pursue a well-rounded Ivy League education. In fact, English was his second choice for a major.

To balance the challenging workload at Princeton, Frank became involved in the varsity sailing team and served as its co-captain in both his junior and senior years. A love of sailing was also a result of his father's influence; his father had built his own sailboat when Frank was only five. In his senior year, Frank was awarded the "Class of 1916 Cup" for the varsity athlete graduating with the highest GPA.

On the academic front, the biggest influence on Frank while at Princeton was Roy Jackson, with whom he worked on his senior thesis. Frank's thesis won the

Xerox Prize for the most outstanding thesis in the chemical engineering department. Professor Jackson's command of the English language and his ability to communicate ideas in the classroom greatly influenced Frank's decision to pursue an academic career, and it set a standard for Frank in effective classroom teaching. Roy was also a role model as a mentor, and he taught Frank the valuable lesson of impartial advising.

In 1985, as graduation neared, Frank kept all his post-graduate options open as he applied for business school,

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engineering graduate school (chemical and nuclear), industrial positions, and study-abroad programs. "It's good to have options," he observes. He also weighed a decision to join the nuclear navy when he was a junior at Princeton. He soon realized, however, that submarines were a poor approximation for sailing on the surface, and he quickly came to his senses and decided to go to graduate school instead.

In the end, Frank was drawn to the field of process control as his graduate research topic. There were a number of events that steered Frank toward the field of dynamics and control. They included summer internships in 1981 and 1982 with a process control instrumentation company (Process Control Inc.), as well as a senior-year course in process dynamics and control.

After talking to Professor Jackson about his experiences as a student at Princeton, Frank decided to spend a year at Cambridge University and was awarded a Winston Churchill Fellowship in 1985. He worked with professor Allan Hayhurst on the development of an ionization sensor for a spark ignition engine.

This thesis project was in some ways a prelude to his PhD work as his project involved a novel sensor for a feedback loop in an engine control system.

In Frank's effort to immerse himself in the local British lifestyle, he took up rowing, cricket, and pub hopping. His rowing activities eventually led to participation on the chemical engineering boat to race in the Cambridge town bumps. His team went on to "bump" each of the four nights of the regatta, and each member was awarded his own oar as a trophy. That oar is Frank's prized souvenir from his Cambridge days. At the end of his year there, Frank was awarded the W. Averell Harriman Scholar prize for being "the most outstanding Churchill Scholar" in the program in 1986.

Leaving the dreary weather of England for sunny California, in the fall of 1986 Frank began work on his PhD at the California Institute of Technology. He chose that program because of its intimate class size and because of the international reputation of Manfred Morari's research program in process control there. Morari taught Frank about the importance of close interaction with students as well as how to think critically. Frank practices what he learned with his own research group by having weekly one-on-one meetings and weekly student seminars, and by setting a high standard for the group.

In spite of the grueling schedule of graduate school, Frank found time to keep his love of sailboat racing alive. He was fortunate enough to become part of a three-person team and qualified for the World Championship in the Echells class while at CalTech.

But, sailing had an even more important consequence in Frank's life—he met his future wife, Diana, during a regatta weekend in Newport Beach.



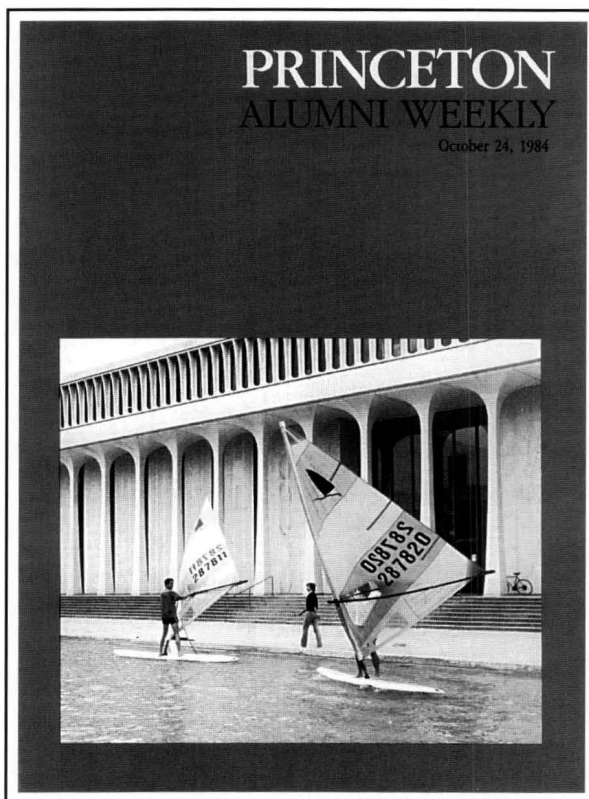
Members of the Churchill College rowing Team at Cambridge University competing in a regatta on the river Cam in the fall of 1985. Frank is rowing in the stroke position facing the coxswain.

TEACHING AND RESEARCH

In 1991, as Frank was putting the finishing touches on his PhD, he accepted an offer to teach at Purdue University. Recognizing the practical nature of Purdue's program, however, he felt he would be a better teacher if he had some industrial experience under his belt before standing in the front of a classroom. A chance meeting with W. David Smith at the CPC IV meeting led to working for DuPont in 1991, prior to commencing his career at Purdue. Dr. Tunde Ogunnaike, a collaborator from the group, recalls:

My first professional contact with Frank began as a result of a program instituted in 1990 at DuPont. In an attempt to promote more meaningful interaction between academia and industry, with the objective of encouraging research efforts focused on problems of industrial significance, our group at DuPont instituted an academic visiting-scientist program. The first ever "Young Faculty" visiting position was offered to Frank. By the end of his year in this program, Frank had established what would become the gold standard by which all subsequent program participants would be measured. I had the privilege of working very closely with Frank during this one-year period; it was to be the beginning of a long and fruitful collaboration that continues to this day.

Nearly ten years after, it is now possible to see the importance of Frank's year at DuPont in shaping his career; from his teaching style and his selection of research problems to the formation and operation of the University of Delaware Process Monitoring and Control Consortium. Each activity bears the unique trademark of strong theoretical and analytical fundamentals appropriately tempered with practical considerations. Frank has also evolved into one of only a few academicians who are well-regarded both in industrial as well as



Princeton Sailing Team Co-Captains, Frank Doyle and Rob Schoelkopf pull a stunt with windsurfers in the Woodrow Wilson Plaza pool that landed them on a 1984 cover of Princeton Alumni Weekly.

academic circles; in Frank's case, he is not only a productive researcher, he is also an all-around good citizen of the chemical engineering community at large.

While at DuPont, Frank learned about practical problems and the challenges in implementing control in the real world. He collaborated with Tunde and Ron Pearson on Volterra series model-based control; they have continued those interactions through the years and are presently writing a book on the subject. Frank also kindled an interest in biosystems control through a collaborative project with Tunde and Jim Schwaber, and that collaboration has likewise been maintained through the years despite several employment changes by both Jim and Frank. They studied the way that nature regulates blood pressure on a beat-by-beat basis; that project led to a major thrust of biosystems analysis and control in Frank's research—several

years before the DuPont Life Science revolution took place.

In the fall of 1992, Frank headed to Purdue to start teaching and building his own research group. His research program took root quickly, and he was awarded the National Science Foundation's National Young Investigator Award for his process control work in 1992. This was followed in 1996 by the Office of Naval Research Young Investigator Award for his research on biosystems analysis and control.

Purdue introduced a new teaching challenge for Frank—a large classroom environment. But, he took it as an opportunity to establish his lectures with multifaceted ways of interacting with his students through a combination of lectures, labs, help sessions, and office hours. He organized a tutorial session in the evenings with the dual purpose of going over some complex problems that would capture the attention of the accelerated students and solving them in complete detail for the benefit of students who need a little extra help.

Frank was greatly influenced in his teaching style by Phillip Wankat, who taught a course at Purdue on teaching engineering. In that class, Frank first learned about the "learning types" that helped him in approaching diversity in the class-

room. His hard work and dedication paid off. Frank was awarded many teaching awards in the next few years, including ASEE Section Outstanding Teacher Award (Illinois/Indiana, 1996); Shreve Prize, Chemical Engineering Department teaching award, 1995, 1997; A.A. Potter Award, School of Engineering teaching award, 1995; Purdue's Teacher's for Tomorrow Award, 1996; and Tau Beta Pi's Dean Marion B. Scott Exemplary Character Award, 1996. In 1996 he was also inducted as a member of the first group of elite teaching faculty in the Teachers-for-Tomorrow program.

Frank also began development of a set of educational software modules while at Purdue. With the encouragement of his departmental head, Rex Reklaitis, he created a virtual laboratory for process control—constrained by the large class sizes at Purdue (as high as 200 graduating seniors). After a number of years of hard work by his graduate and undergraduate students, the modules were published as a book in 1999 by Prentice Hall, under the title of *Process Control Modules—A Software Laboratory for Process Control*.

In addition, Frank established a significant program on both traditional process control and in the area of biosystems control that he had studied at DuPont. The traditional process control research was expanded by interactions with the other process systems engineering faculty at Purdue (Reklaitis, Pekny, Venkatasubramanian). The four faculty co-founded the very successful Computer Integrated Process Operations Center (CIPAC). One of the themes that was championed by Frank was the application of advanced systems engineering methods to the pulp and paper industry. He would later place two of his Purdue PhD students at top pulp and paper companies, and has established himself as a leading researcher in that industry. Dr. Philip Wisniewski, one of Frank's first PhD students (presently at Weyerhaeuser) recalls:

Frank has influenced me, as he has many of his students, by the example of professionalism that he exudes. He sets very high standards for himself; and through his dedication to teaching and research; through his sincerity, honesty, and loyalty in dealing with others; and through his support and encouragement which he freely offers to his students, he inspires those around him to set high standards and expectations for themselves. Frank is truly a gentleman, a person of quality and integrity.

Frank also expanded his biosystems research activities to include biomedical-engineering control problems and began a collaboration with Nicholas Peppas in 1994 with two jointly advised graduate students in the area of controlled drug delivery for diabetic patients. One of those students, Robert Parker, is now an Assistant Professor in the Chemical Engineering Department at the University of Pittsburgh. Professor Peppas offers these words to describe his colleague:

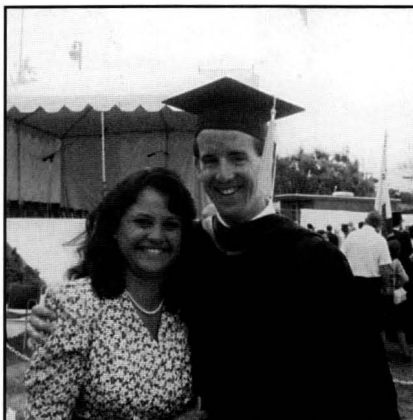
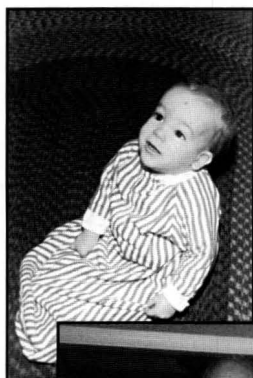
Frank is a truly unique individual, an outstanding researcher, and a most gifted teacher and educator. He brings a great deal of creativity and ingenuity to the classroom. By bringing his real chemical engineering experiences to the students, instead of just textbook examples, he not only helps them to learn but also to want to learn even more. For Frank, teaching is not a job, but a mission.....Our research interaction over the past six years has taught me that he is one of the most imaginative and innovative chemical engineers of our times. He has an uncanny ability to grasp difficult biomedical ideas and transfer them to the level of systems theory.

On a personal note, although Frank was far from the coast while he was a Purdue, he still sailed as often as he could on Lake Michigan, often accompanied by his wife Diana and his daughters Sara and Brianna.

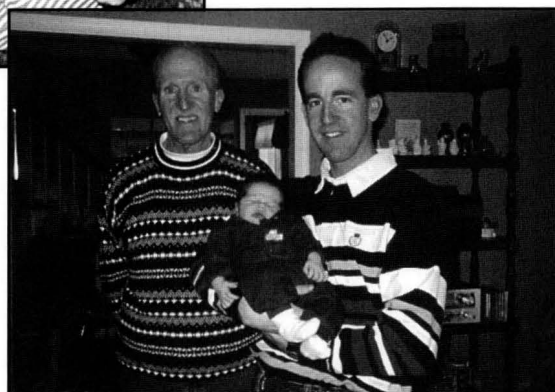
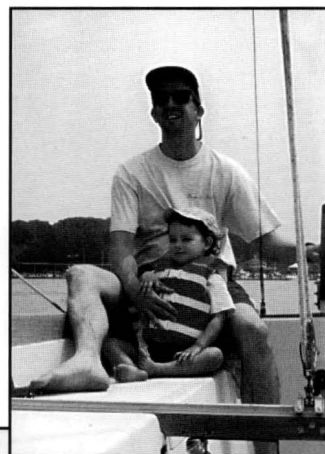
***“ . . . he
is not
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a productive
researcher,
but he
is also
an
all-
around
good
citizen
of the
chemical
engineering
community
at
large.”***

Family Album

Frank, at one year of age (top) and all grown up, the centerpiece of three generations of Doyles (bottom). ▽



◀ *Frank and his future wife Diana at his PhD graduation at CalTech in June of 1991.*



Frank has introduced his daughters to his favorite hobby—sailing. Here with

two-and-a-half year old daughter Sara (top) and one-year-old Brianna (bottom) aboard their sailboat "Son of a Sailor" in 1998.

DELAWARE DAYS

In 1997, Frank took advantage of an opportunity to move closer to home; he accepted a faculty position at the University of Delaware. It was a rare opportunity to advance both his professional and personal pursuits. Here, Frank continues to make a major impact on innovation in teaching. In the spring of 1998, he was one of several instructors to beta-test a new program for a web-based class organizer called SERF (Server-side Educational Records Facilitator). SERF allows students to view curriculum, homework questions, send e-mail to the class and to the professor, check on their progress in the course, and review lecture notes. Frank has published conference papers and a book chapter about his experiences using SERF for control education. He was also inducted as a Fellow in the NSF-sponsored Institute for Transforming Undergraduate Education at the University of Delaware.

Frank was also the first instructor at Delaware to employ live video streaming via the Worldwide Web in his fall 1998 control class. He worked with the staff of Media Services to

create an on-line version of his course to facilitate the schedules of students who were on industrial internships as well as to engage a more geographically distributed continuing education audience. The experience formed the basis of an invited book chapter on the subject. A student taking the class off-site said

It has given me the knowledge and insight into the subject that would have taken me several years to acquire on my own. Prof. Doyle was very receptive to student questions both in and out of class and was very professional.

As mentioned earlier, Frank has also developed an interactive software package for undergraduate dynamics and control education known as PCM (Process Control Modules). The modules were published in the fall of 1999 as a textbook with the CD-ROM. The software is developed in the MATLAB and Simulink environment and incorporates several realistic simulation models of industrial unit operations (furnace, distillation column, bioreactor, pulp digester, chemi-

cal plant). The accompanying exercises demonstrate dynamic analysis, PID controller design, frequency response analysis, and controller tuning. There are numerous chemical engineering departments in the world using this software for process control education.

Another of Frank's teaching innovations at the University of Delaware was the development of a college-wide interdisciplinary, experimental control-engineering course. The course is centered around a state-of-the-art laboratory developed using actual industrial control equipment and software from Aspen Technology, ABB/Bailey, and Honeywell. The experiments include a distillation column, a gyroscope, an inverted pendulum, a servomotor, a level control system, and a spring-mass damper. The course has drawn students from chemical, electrical, and mechanical engineering as well as from operations research, which is outside the college.

Frank's educational activities were recognized in 2000 by the Ray Fahien Award from the Chemical Engineering Division of the ASCE. He is also serving on the Provost's Teaching and Learning Technology Roundtable, which has a mission to define the university's vision for effective teaching technology tools.

The work of Frank's research group at Delaware is characterized by two dominant themes: 1) the application of nonlinear model-based control techniques to multivariable, nonlinear, constrained industrial processes, and 2) the use of systems-analysis tools as a bridge between chemical engineering and biology through neuromimetic and therapeutic approaches. At Delaware, Frank has also taken on a new research challenge—an experimental project. His group built a pilot-scale emulsion polymerization reactor shortly after their arrival that is interfaced to state-of-the-art industry sensors and control hardware. With an objective of particle size distribution control, it will serve as a test bed for a number of control projects in his research program. Frank feels there is no simulation substitute for the complex nonlinear behavior that his research team will face in trying to optimize the operation of this system.

The practical impact of Frank's research is also evidenced by establishment of the University of Delaware Process Control and Monitoring Consortium in 1998, shortly after his arrival. Frank is the director of this Consortium that has the support of twelve industrial companies and involves collaborations across campus, including chemical engineering, mechanical engineering, computer science, and computer engineering. The Consortium structure enables participation of both industrial companies and control vendors with the university in the pursuit of applied research.

SERVICE

Frank maintains a healthy perspective about service work

in the academic profession: "...it is the responsibility of the most active members of the teaching and research community to take a leadership position in service activities." As such, he has served on a number of important committees, including the graduating recruiting activities at both Purdue and Delaware. He has served on many search committees, including three concurrently in early 2000. He holds two editorial posts with the *Journal of Process Control* (Special Papers Editor) and *IEEE Transaction on Control Systems Technology* (Associate Editor). He has organized or chaired over thirty sessions at meetings of the AIChE or ACC and is on the International Programming Committee of many of the conferences in the process control area. His teaching service has led him to give lectures to high school teachers on technology topics as well as to the members of the Academy for LifeLong Learning (a continuing education group for retirees) on diabetes therapy research.

Although Frank is a young faculty member, he has already had a large influence on the students in the profession. He estimates that approximately 900 seniors have taken his process control course, and of those, approximately 40 have done independent research projects under his supervision. He is presently advising, or has supervised, over 20 MS and PhD students in his relatively short career.

PERSONAL LIFE

Frank was born in Philadelphia in 1963, but moved to Newark, Delaware, at the age of 2. He was the oldest of five children and has three sisters and a brother (Patrick—also a chemical engineer). Frank married his wife Diana in 1992 and they have three beautiful children: Sara (age 4), Brianna (age 3), and newborn Francis Joseph IVth. Now that Frank is "back home" in Delaware, he enjoys sailing the Chesapeake with his parents and hopes to introduce his children to the excitement of sailboat racing. Another perk of returning home is the renewal of hope for ending a 25-year losing streak on the tennis court to his father. He is involved with the Knights of Columbus in the Parish where he went to grammar school.

THE FUTURE

Frank sees many changes ahead for the field of chemical engineering, both in teaching and research. There is no question in his mind that future research successes will occur at the boundaries between disciplines, and he feels confident that biosystems and chemical engineering will be a fruitful path. On the educational front, he sees similar challenges as the new ABET requirements put an increased emphasis on interdisciplinary coursework. He is presently working with his Dean and the department heads in the college to create a common control engineering course for all the engineering majors. He also has plans to tap the power of the World Wide Web to create tools for process control education. □