

C. Stewart Slater



*of Rowan
University*

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*Above: Stew in the atrium of Rowan Hall, home of the Chemical Engineering Department.
Below: Stew's students compete on his hand-held reverse osmosis experiment.*



It is always an exciting time seeing chemical engineering students in the classroom working vigorously on an experiment. Teams of students are at a station that has a hand pump connected to a cylinder, a tank of blue salt water, and a second tank with a small amount of clear fluid. Next to these students there is a professor who is vigorously encouraging these students to “Pump it up!” He has gotten

them so excited that they are competing to see how quickly they can fill a 1-L graduated cylinder with pure water. Then you remember that C. Stewart Slater (Stew) is teaching reverse osmosis membrane separations today! Next you hear Stew commenting, “Now you can physically understand the applied pressure necessary to overcome the osmotic pressure of the salt solution.”

Stew exhibits this high level of enthusiasm whether teaching students, faculty at workshops, or board of trustees members of the university. Based on his accomplishments, Stew has received many accolades for his teaching, research, and service activities.

But Stew considers his most significant achievement to be the job he did as founding chair of the Chemical Engineering Department at New Jersey’s Rowan University, a school that he’s proud to say has provided the opportunity for students from the part of his home state locals call South Jersey to receive a first-rate chemical engineering education. Supporting that belief: The program he created has been ranked by *U.S. News & World Report* as one of the country’s best

undergraduate chemical engineering programs for seven consecutive years (2003-2009).

GROWING UP AT THE JERSEY SHORE

Stew grew up in Ventnor, N.J., a small resort town on the South Jersey shore. He was the youngest child in a family of professional educators. His father was a department head at Atlantic City High School and his two older sisters are both teachers, Susan in elementary education and Elizabeth in high school mathematics. The Jersey shore was a great laboratory for a young scientist. Digging in the sand for crabs and observing the dynamics of tides and beach erosion were nearby introductions to natural phenomena that fascinated him. Even today, Stew usually spends his weekends at the Jersey shore with his sisters and mother who still live in Ventnor. He comments that although the region has changed a lot in the last several decades, it is always comforting to come back to the place where you grew up.

Stew excelled in elementary and middle school; he always loved math, science, and history topics. Stew went to Atlantic City High School, where he followed a college-prep track with emphasis on science and mathematics. He took A.P. chemistry in his senior year and says that the intense laboratory experience and project work made the class



fun. His math experience was equally engaging, advancing to A.P. Calculus in his senior year and winning a school award for excellence in mathematics. His teachers encouraged him to consider an engineering career.

During high school, Stew worked part-time for the various conventions held in Atlantic City hotels and the convention center. One of these would have a pivotal impact on his life. In 1971, he worked as a session aide for the AIChE 70th National Meeting in Atlantic City. At this meeting, Stew got the chance to hear various talks from the sessions he aided. One session focused on pilot plants, which really excited Stew because of the concept of how processes are scaled up.

ON THE BANKS OF THE RARITAN

When Stew made the decision to go to college to study engineering, he looked at many colleges and attended the open house at Rutgers University in New Brunswick, N.J.. He was most impressed with the chemical and biochemical engineering department's equipment demonstrations, and became convinced that this program was the best choice for him.

Stew excelled at Rutgers, earning straight A's in his first Spring term. Sadly, his father died of cancer in the summer after his freshman year, but Stew's strong faith and family helped him through this difficult time. Stew says he was always encouraged in his career that he was following in his father's footsteps.

While at Rutgers, Stew joined AIChE as a student member and in his senior year was elected student chapter treasurer. Stew helped the chapter with a fund-raising campaign to support student activities such as a Thanksgiving party with turkeys and cider, and numerous social events. He especially enjoyed the camaraderie with fellow engineering students. Before teamwork was as popularized as it is today, Stew was a member of a study group that he recalls as being key to helping him succeed; the benefit students gain from working with other team members on various assignments was something he learned to appreciate first-hand.



Left, Stew playing and learning on the Jersey shore. Right, Stew with sisters Elizabeth and Susan (l to r).

Stew with his college friends and study group at Rutgers: (l to r) Stew, John Jacquin, George Swier, John Nikityn.



When Stew graduated in 1979, he interviewed with many of the companies that visited campus. He was intrigued with non-traditional aspects of chemical engineering, so a presentation by Procter & Gamble on chemical engineering in product development excited him. Stew accepted a job offer in Product Development for their Personal Products Division, located in Cincinnati, Ohio. He worked in dentifrice (toothpaste) process development on a gel-based product to complement the Crest® line. He met senior scientists and engineers from the Research Division, and soon realized that a career path in research would require an advanced degree. He was also told that his presentations were quite good and that he should consider being a professor since he was able to explain difficult concepts equally well to technicians and to non-chemical engineers.

When Stew decided to return to graduate school, he talked to his former professors at Rutgers, who strongly encouraged him to come back. At that time, Robert Ahlert had secured a major grant from the U.S. Environmental Protection Agency to examine the treatment of hazardous wastes from landfill leachates. Stew signed on to Ahlert's group at Rutgers and worked on the use of membrane processes, such as ultrafiltration and reverse osmosis, in the treatment of the leachates from a New Jersey Superfund site. One of the aspects Stew liked best was when he got the chance to involve undergraduate students in his research. This provided a meaningful mentorship opportunity for these students as well as giving Stew the chance to learn how to effectively supervise students. He also enjoyed his teaching duties when he was asked to fill in for a

faculty member going to a conference or to help undergraduates with class projects and grade homework assignments.

IN THE BIG APPLE

While completing his dissertation, Stew pondered his future plans and decided to enter the academic ranks, once again honoring his father's influence. He wanted to work for an institution that valued teaching while allowing him to continue developing his expertise in membrane processes.

In September 1983, he accepted a tenure-track position at Manhattan College. There, Stew immersed himself in the triad of teaching, scholarship, and service, and rose through the ranks, reaching full professor in 1992. During his time at Manhattan, he was very active in developing new laboratories for advanced separation processes and biochemical engineering with financial support from the National Science Foundation and from industry.

Stew says that he was influenced by numerous faculty members during his time at Manhattan College, including Br. Conrad Timothy Burris and Helen (Connie) Hollein. Br. Burris, who was Stew's first department chair, provided the support and encouragement necessary for faculty development and initiated Stew's involvement in ASEE. Connie was hired the year before Stew and they shared many of the growing pains of new faculty. They also worked together in the areas of educational development and bioseparations research. Stew earned high marks for his teaching, research, and service, and was recognized by his peers with the ASEE New Engineering Educator Excellence Award, the Dow Outstanding New

Faculty Award, and ASEE's Fluke Corporation Award for Excellence in Laboratory Instruction.

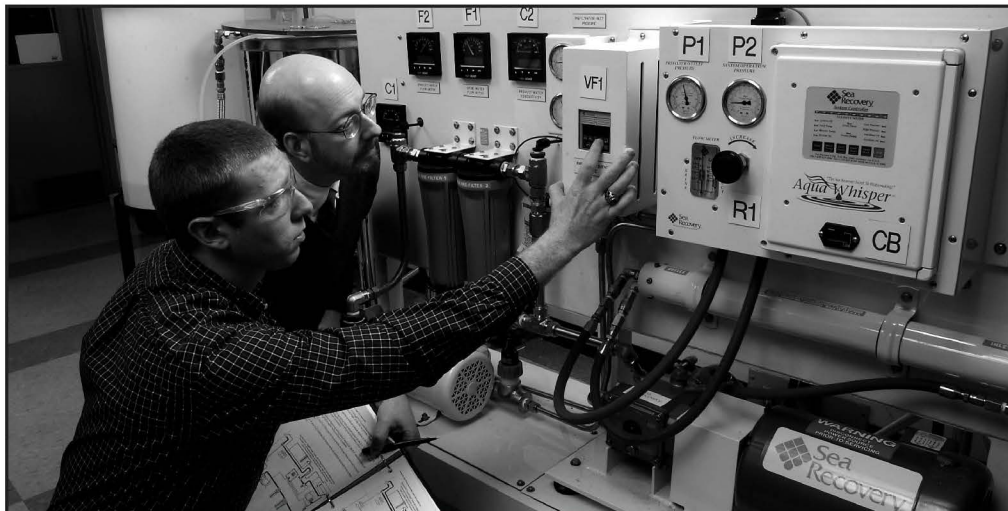
Stew continued to expand his research and teaching interest in membrane technology, developing new courses at both the senior and master's level. He analyzed what was taught in separations courses and found that new separations, such as membranes, were underserved. As a result he developed methods to incorporate membrane processes. He developed new courseware and experiments for membrane processes that are still used in Manhattan College's undergraduate laboratories (as well as in other universities across the country). His work resulted in many pedagogical publications and in new approaches that would later earn him the prestigious Chester Carlson award from ASEE. It also left a positive impact on the many whose lives he has touched. Stew embraced the LaSallian tradition of excellence in teaching.

As A Teacher

Br. Christopher Dardis, who served for many years as director of Manhattan's Center for Teaching & Learning, remembers Stew fondly as a faculty member who came to him for help to improve his teaching—help he clearly did not need, as Br. Christopher calls Stew one of the best teachers that he has ever seen. Br. Christopher cited Stew's demonstrations with "cut-away" membrane modules as an ingenious and highly effective teaching method.

Connie Hollein, who served as Chemical Engineering Department Chair after Br. Burris retired, recalls Stew's winning style in the classroom. "He was one of the most organized faculty members I've known, with step-by-step detailed notes and the reputation as a tough but fair teacher." But in balance with that serious side, Connie notes, "His jokes and funny stories kept the students engaged even at the end of a long day."

She recalls one story in particular: "When he showed a cut-away hollow fiber membrane permeator to the students, he would tell them that last year's class took one of the cut-away permeators and he didn't know where it went. He went on to claim that at the end of that semester, he got a present from the class and it was the hollow fiber permeator—with the fibers removed and cut up into a hair piece for him! Then, he takes a cut-up bundle of fibers and places it on his head. The *whole class* erupts in laughter!"



Above, Stew with a student in the Unit Operations lab; below, working with a student on a membrane laboratory experiment he developed.



As a Mentor

Supplementing his natural gifts in the classroom, Stew was mentored by Br. Burris in how to obtain industrial funding from industry for his research activities. His research focused on: reverse osmosis for industrial waste minimization, modeling and simulation, and water recovery and reuse; ultra/microfiltration for protein separation; and pervaporation for separation of various organic-water mixtures. He became well known for his work in organophilic pervaporation, which provided him an opportunity to attend numerous international conferences and seminars. These projects were supported by various companies including Air Products & Chemicals, ExxonMobil, Pfizer, Joseph E. Seagram & Sons, and United Technologies. In all of these projects Stew passed along the gift of mentoring, involving undergraduate and master's students, many of whom went on to obtain advanced degrees and



related positions in industry, academia, and government.

Kevin Devine, who has risen to the current job title Group Leader at Kraft Foods, Inc., says, “Dr. Slater was a demanding research advisor but did it in a way that encouraged us to succeed with our pervaporation projects. His mentorship taught me numerous things from experimental design and effective time management to presentation techniques, all of which have helped me advance in my professional career.”

Stew is deservedly proud of the successful careers of his research students and of the fact that four of his pervaporation research students won Manhattan’s campuswide Sigma Xi medal for research, and three won awards when they presented research papers at International Pervaporation Conferences.

Another former student, John Paccione—currently with the New York State Department of Health and on the faculty of State University of New York at Albany—was an undergraduate who worked with Stew during his early years. “Stew taught me how to design, develop, and operate state-of-the-art reverse osmosis systems. This work provided my colleagues and me with a greater view of opportunities in chemical engineering and an introduction into the activities of research. One of Stew’s greatest abilities was to inspire students to work to higher levels of achievement, which in my case included earning a Ph.D. at Rensselaer Polytechnic Institute. One of the greatest attributes of an educator is the ability to inspire his students and to provide visions of the possibilities beyond the classroom.”

Marco Castaldi (now on the faculty at Columbia University) is another former student. He remembers Stew for his genuine interest helping Marco during unit operations laboratory. Marco comments, “Unlike most professors in charge of student laboratory courses, Stew took the time to read my preliminary report and suggest improvements and changes that enabled me to see the important aspects of the labs. This directly translated to my abilities to develop excellent laboratory skills and techniques that have served me well during my graduate studies and subsequent industrial and academic career. In the classroom, he showed another side. One in which he could present complex, new material in a way that left you feeling confident you could understand and use it in real-life applications.”

As a Peer

Early in his career, Stew became quite active in professional societies and attended AIChE, ACS, and ASEE conferences to present papers and network with colleagues. One of the professors that he met at ASEE meetings, Angelo (Angie) Perna of New Jersey Institute of Technology, encouraged him to get more involved in that society. Stew began to rise through the ranks of leadership in ASEE, first in the Division for Experimentation and Laboratory-Oriented Studies (DELOS) and then in the Chemical Engineering Division, rising to Division Chair in each. Stew currently serves as vice-chair of the publications board of *Chemical Engineering Education*.



*Facing page, Stew teaches other teachers at an NSF workshop.
Left, Stew at the ASEE 2003 Annual Conference along with Rowan Chemical Engineering faculty Stephanie Farrell (far right) and Robert Hesketh (second from left), who are flanking ASEE President Jerry Jakubowski.*

SOUTH JERSEY HOMECOMING

In 1992 Henry and Betty Rowan gave a gift of \$100 million to start a new engineering school at Glassboro State College, which was renamed Rowan University in their honor. When the enviable position of founding chair of Chemical Engineering at the university was being created in 1995, Stew was a finalist for the job. Dean James Tracey recounted that Stew was very excited about this opportunity since it was a rare chance to create a new way of teaching engineering. Stew was additionally eager to return to his roots in southern New Jersey, where his family still lived. In pursuing the post, Stew's showman skills stood out. Jim Tracey comments, "Stew insisted on doing a membrane demonstration during his interview that really impressed me; I had never had a candidate insist on doing a demonstration before. But, Stew firmly believed in 'hands-on education,' and knew that this would be a critical component of our program." Stew got the job.

He spent his first year at Rowan multitasking—splitting time between curriculum development, facilities/lab development, student recruitment, and faculty recruitment, each of which had its challenges. Jim Tracey challenged the founding chairs to create an innovative program that would produce a 21st Century engineer. The resulting curricula was designed to produce graduates who could communicate effectively, have knowledge of business/entrepreneurship, work in multidisciplinary teams, and have a hands-on, minds-on approach to problem solving.

During Stew's initial year at Rowan he spent many hours working on plans for an innovative engineering building. Stew, who is well known for his detailed planning, devoted many hours to ensuring that the engineering labs were suited for chemical work. The end result is that every room in Rowan Hall has the capability of being easily converted to a chemical laboratory. Stew worked tirelessly on making sure

that the fresh-air exchange, hoods, point exhausts, and the like were sufficient to support chemical work. Of course, water sources and drains were placed in every lab, but Stew made sure that a pressurized water system was installed in the building so that no experiment would have a shortage of water flow in high demand times. Similarly, pressurized air, vacuum, and steam lines were placed in the building. Again, to get the steam lines Stew had to work with the architectural firm to install a special heat exchanger on the fourth floor. Most notably in this building, Stew had to defend the need for high bay laboratories that at first got removed from the plans as a cost-cutting measure, and then were reinstated only after his defense of these as absolutely necessary for a hands-on, minds-on curriculum.

Stew instilled the quote "Tell me and I forget, show me and I may remember, but involve me and I understand," that he attributes to Benjamin Franklin, as a fundamental philosophy for the engineering college. For example, one of the essential jobs of the first chairs and dean was to recruit a new set of students to a new program—without an engineering building! This tall task involved many trips and visits to high schools and college fairs alongside admissions office staff. As Jim Tracey recalls, Stew's unique slant on this activity was to bring his trademark hand-held reverse osmosis demo to allow high school students to get involved and run an actual chemical engineering process. Stew was able to convince students that Rowan would not be a place where you only sat in class and took notes; instead Rowan would be the place where you would become actively engaged in the learning process. Stew also convinced the University Board of Trustees that engineering at Rowan would be unique by having *them* perform this same experiment.

In working with the other founding chairs, Stew contributed to developing a program in which students are involved in the learning process from the first day of the program,

through multidisciplinary engineering clinics. These clinics are similar to the medical school approach to teaching (first used in engineering by Harvey Mudd College) in which students work in teams on actual engineering problems each semester. Each section of the engineering clinic sequence involves students from all four of the engineering disciplines, and many of the clinic projects are funded by industry and faculty-research grants. The Rowan program was one of the first in the country to have a one-year freshman experience with engineering experimentation, multidisciplinary teamwork, and communication skills. In the Fall semester, students start by conducting guided experiments, and then finish the semester with an open-ended project.

In 1996 the first engineering clinic was housed in an old cafeteria, which especially pleased Stew because he had water and what appeared to be drains. After doing some plumbing, these freshman students worked with pressure and flow measurement devices using newly purchased 40-gallon tanks. The students also learned some on-the-job training in trouble shooting: They found that the cafeteria drains had been plugged from previous use, and they observed that water will always take the path of least resistance!

In the Spring semester the freshman engineers worked on a reverse engineering project that focused on the coffee machine—a perfect match for a food-grade cafeteria lab.

By the time the first class graduated in May 2000, eight faculty had been hired and the labs were full of equipment and advanced instrumentation for teaching and project work. Based on his educational innovation and leadership, Stew was awarded the George Westinghouse Award from ASEE in 1996. Several years later, in 2000, ASEE recognized him with the Chester Carlson Award for his innovations in developing laboratory experiments and course materials on membrane technology. Stew excelled in teaching future educators at ASEE Summer Schools, EPA workshops, and NATO Advanced Study Institutes. He has conducted six NSF-sponsored workshops on novel process science and engineering, membrane technology, and advanced separation processes.

Stew's experience gained from some of his initial faculty workshops was very useful in inspiring new experiments for use in the Rowan courses. Stew helped faculty to obtain funding for these new teaching methods by introducing them to the NSF funding opportunities in laboratory development as well as in presenting national workshops. Through his leadership, faculty started out as co-PI's on these grants and then were mentored by him and became the lead on new education grants. Stew recalls one of the best things about Rowan is this willingness of faculty to work collaboratively. Whether it is team teaching a class or partnering in supervising a clinic project, the enthusiasm of faculty to work in teams has provided rewarding learning experiences for both students and faculty. Stew has worked alongside every member of the department—Kevin Dahm, Stephanie Farrell, Zenaida Ge-

phardt, Robert Hesketh, Brian Lefebvre, James Newell, and Mariano Savelski—on educational and research projects.

As chair, Stew encouraged Rowan's talented young faculty to develop and publish their educational innovations. Kevin Dahm points out, "Stew served as an outstanding mentor and passionate and effective advocate for his faculty. His support and encouragement led to numerous national awards garnered by members of the department." Once again, Stew's detailed planning paid off. He had even listed in advance who would be nominated for regional and national awards.

Rowan's Junior and Senior engineering clinics are primarily sponsored by industry. Getting these sponsors requires a tremendous amount of energy and skill. Not surprisingly, Stew was a very effective pitchman in obtaining sponsors; his tremendous enthusiasm and ideas are very convincing. He was the lead presenter to nearly all of the sponsors of engineering clinic projects during his tenure as chair, and faculty who have presented with him have observed the effectiveness of these presentations to industry.

Stew acknowledges that industrial clinic projects have been the most interesting to him, especially those with either food or pharmaceutical companies. His involvement in most of these projects has been in his area of interest of membrane separations, but recently Stew has "gotten green." He has been involved in EPA projects on the development of educational modules in green engineering for the undergraduate curriculum. In the last several years he has collaborated with Mariano Savelski on green engineering research in pharmaceutical manufacture focusing on organic solvent metrics, solvent reduction/recovery, and life cycle assessment, funded by EPA, Bristol-Myers Squibb, and Pfizer.

Mariano says, "Working with Stew has been a wonderful experience for me; he is one of the best-organized people I have ever worked with. His attention to detail, his perseverance, patience, and organizational skills are beyond description. In our projects, he helps guide students by giving them clear objectives for their work. As they present the results of their work he gives detailed feedback to the students both in meetings with students as well as on their written work."

Mariano is also impressed with Stew's planning, "He never misses a deadline! In fact, Stew always has everything ready days, if not weeks, in advance."

Stew's attention to detail was essential for starting a new department. He is always prepared for every meeting whether it is with an individual faculty member or the entire college of engineering. Based on either his agenda or an agenda he has been given, Stew carefully considers each point listed and makes extensive notes on his yellow legal pad. During the meeting he continues to take notes on important aspects so that they can be relayed to faculty. Stew's careful pre-planning was very useful for keeping discussions focused on accomplishing the required tasks on the agenda. One example of his attention to detail was in planning and

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— A former student

preparing an NSF-sponsored workshop. In addition to all that is required in developing new experiments, preparing lecture and lab sessions, printing handouts, and recruiting participants and speakers, Stew paid attention to even the incidental details—pillows, for example. He personally visited every dorm room that the faculty would be staying in to make sure that it was suitable; when he discovered bed pillows were in short supply, it was Stew who went out and purchased them.

Stew also makes extensive use of this aptitude for planning in his lectures and presentations. His lecture notes are filled with comments directing students to conduct active-learning exercises as well as notes on some of his famous jokes. Class after class of students have been amused and bemused by Stew’s sometimes corny take on the subject matter.

In a lecture on thermal conductivity for building materials Stew tossed students a curve by asking them to look up, “What is the value for steel? For plywood?...*For the natural log?*”

Stew loves to stretch the truth and turn things around—“Did you know the origin of membrane terminology can be found in the Bible? Moses was a breach birth so when he was born they exclaimed ‘Reverse Moses’ (Reverse Osmosis).”

Brian Lefebvre, who co-teaches the separation course with Stew, remembered the lecture on ion exchange membranes. Stew first shows the class two similar-looking polymer sheets and asks which one is the cation and anion exchange membrane? After the students give a variety of answers, Stew then holds one of the sheets close to a student’s ear and obliquely makes a “meow” sound. (He uses this example to illustrate the importance of doing experiments.)

Stew says that the success of the Rowan chemical engineering department is based on the great faculty that he is blessed to be working with. He views his role of founding chair to go beyond the “bricks and mortar” of a start-up program. Jim Newell comments, “Stew built a department that ran

like a family. He mentored a generation of faculty members with concern, humor, and a genuine commitment to helping each one of us develop to our fullest potential. Stew always said that his job was to hire people that could become even more successful than him and then to help them achieve that potential.” Stephanie Farrell adds, “Stew is thoughtful, considerate, loyal, and a natural leader. As a friend and colleague he consistently puts others before himself. His work ethic and dedication to education are well known; during his time as department chair he was admired for his fairness, preparedness, and dedication, all while remaining friendly, pleasant, and easygoing.”

In 2004, Stew decided to return to a faculty position to allow other chemical engineering faculty to gain experience in leadership positions. Through his career he has amassed an impressive record for someone who has taught at primarily undergraduate institutions. He is principal author or co-author (with his students and faculty colleagues) of more than 50 journal articles, 75 conference proceedings, 140 conference presentations, and nine book chapters. He has served as a principal investigator or co-investigator on more than \$3 million in projects from industry and government. He is a Fellow of the American Society for Engineering Education (ASEE) and has received many awards from professional societies. Over the years, he has been asked at times to consider industrial and government positions, but always responds to such queries that “teaching is in my blood.” Stew loves it when a former student visits years after graduation and he can see the impact he has had on that person’s professional career.

Stew reminds seniors preparing for graduation that they are the future of chemical engineering and the ambassadors of the profession. He knows that these graduating seniors may not remember all the chemical engineering concepts they learned or all the jokes he has told. More importantly, Stew wants them to remember two things: to help others, and to use their chemical engineering know-how to serve and improve society. □