Michael Corradini: An educational approach

The 58th president of the American Nuclear Society is an expert in the field of nuclear reactor safety and a firm believer in the power of facts to evince the benefits of nuclear power.

BY TIM GREGOIRE

CALL IT A case of the master following in the steps of the disciple. In June, Michael Corradini took office as the 58th president of the American Nuclear Society, a position previously held by his former student Eric Loewen, who did his doctoral degree work under Corradini's supervision at the University of Wisconsin at Madison.

Corradini, the former chair of the Engineering Physics Department and Wisconsin Distinguished Professor of Nuclear Engineering and Engineering Physics at the Big Ten university, has spent his entire career furthering the knowledge of nuclear science and engineering, and, in particular, the understanding of nuclear reactor safety. The list of articles, publications, and conference proceedings he has authored currently fills more than 20 pages of his 53-page curriculum vitae.

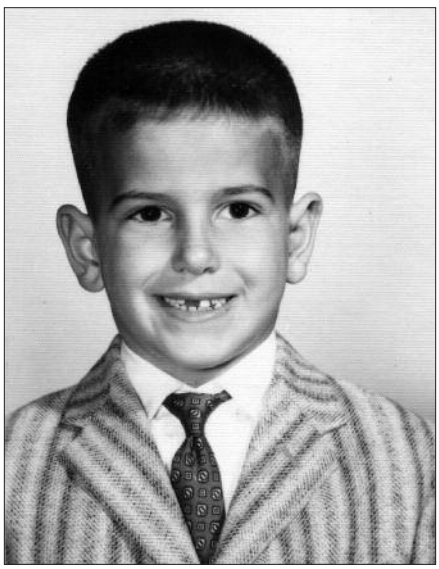
Corradini has served as the presidentially appointed chair of the Nuclear Waste Technical Review Board and as a board member of the Institute of Nuclear Power Operations' National Accreditation Board for Nuclear Training and of the National Council on Radiation Protection and Measurements. He also served on the scientific advisory committee to the French Civilian Atomic Energy Agency and on the U.S. Nuclear Regulatory Commission's Advisory Committee on Reactor Safeguards. This is in addition to the numerous public and private organizations he has advised and consulted.

An ANS member since 1979 and a Fellow since 1990, Corradini has provided a learned voice in the nation's discussion of nuclear science and technology matters. Most recently he has served as cochair of the Society's Special Committee on Fukushima, a role that has put him in front of national leaders, the media, and the general public to discuss the facts of nuclear power. It also took him to Japan in June to meet with the Japanese government and utility executives to discuss the committee's findings, verifying and expanding on what has already been discovered.

It's a life that keeps him very busy and on the road most of the year. So when he does make it back to Madison, he prefers to spend time at home relaxing and decompressing before the next call of duty. At home, said his wife, Jan, he likes to "putter around the house and do yard work." The couple's home is on a large lot on the city's west side, and there is always something that needs tending. Otherwise it's dinner at Laredo's Mexican restaurant or romping with the family's nine-year-old chocolate Lab, Katie.

Early on

Corradini was born in the shadow of Sandia National Laboratories in Albuquerque, N.M., on August 6, 1952, seven years to the day after the first atomic bomb was dropped on Hiroshima, Japan. It was also the year



Corradini at age six, in first grade

Corradini celebrates Christmas with his parents, Frances (Fannie) and Giuseppe (Beppe), in 1970.

the keel was laid for the world's first nuclear submarine, the USS *Nautilus*.

Despite such notable beginnings, Corradini's Southwestern childhood was, in his modest view, "nothing spectacular either way." His father had immigrated to New Mexico from Italy and worked as a wholesale liquor and beverage salesman, and his mother had grown up in Albuquerque. And while Corradini was an only child, he did not lack the company of kin, as both of his parents came from large families. There were, he said, "lots and lots of cousins."

In Albuquerque, Corradini attended Catholic school—both primary and high school—and he says that from an early age he was drawn to the fields of math and science, participating in science fairs and technical programs. Coming out of high school in 1970, he knew he wanted to pursue an education in engineering. "After that, the next step was how to pay for it," he said. "At the time, there were only two schools in the whole state of New Mexico that had engineering as part of their curriculum, and neither interested me."

So after high school, Corradini set out to find the right engineering program. After considering a number of options, he finally settled on a university that would offer the education he wanted and would be affordable. That turned out to be Marquette University, a Jesuit university located in Milwaukee, Wis., noted for its programs in law, dentistry, and communications, as well as engineering.

It was while working toward his undergraduate degree in mechanical engineering at Marquette that Corradini was presented with a fork in the road to his future—one that would lead him to a long and productive career in the field of nuclear engineering.

"In the early 1970s, most engineering schools were very big on the concept of cooperative education, which means that after your sophomore year you tended to go to school one semester, then you worked for a firm in a [particular] area for another semester," he said.

For Corradini, the work side of the cooperative education equation came down to two choices: either sign up with a company working in biomedical engineering—GE Healthcare was busy making X-ray machines on the west side of Milwaukee—or join an electric utility. A growing interest in the new area of nuclear engineering led him to Commonwealth Edison (now Exelon) and its new two-unit 1040-MWe pressurized water reactor plant at Zion, Ill. "After that, the deal was sealed," he said. "I was actually there during the startup of the first unit. That was a lot of fun."

Zion's Unit 1 went on line in 1973, and working at the plant gave Corradini the opportunity to put the calculations and analyses he had learned in the classroom to practical use, doing the actual testing and experimentation needed to prepare the reactors for startup. It also introduced him to many interesting people from a broad spectrum of backgrounds, all involved in the burgeoning field of nuclear engineering.

"A lot of the engineers were new, and they were not from the nuclear engineering programs," he said. "So you met people from all the various engineering disciplines, from science disciplines who moved into engineering, and it was an interesting time, because all of them were very bright and very hard working."

As an undergraduate student, Corradini said, it's difficult to say where one will end up after graduation, but his experience at Zion inspired him to go on to study nuclear engineering at the graduate level. So after receiving his bachelor's degree from Marquette in 1975—a process that took an extra year because of the demands of the cooperative program that required him to split his time between working at Zion and attending classes—he enrolled in the nuclear engineering program at the Massachusetts Institute of Technology, a decision he said was made "partly based on its reputation and partly based on the financial aid that allowed me to go there."

It was at MIT that Corradini first became interested in nuclear reactor safety and, in particular, the phenomenon of vapor explosions. While other students were busy studying liquid metal fast breeder reactors (LMFBR)—the "hot topic" during the mid-1970s—Corradini was asked to work on this "interesting little project" by his advisor, Prof. Neil Todreas. "It was different," he said, "and I'm the type who likes different. I wasn't in with a whole group of stu-

Corradini greets Wisconsin Gov. Tommy Thompson at an energy forum at the University of Wisconsin–Madison in 1998.

dents doing the same thing. I was doing something a bit different by myself. I found that interesting."

When, in 1977, President Jimmy Carter withdrew support of LMFBRs and they fell by the wayside, Corradini said he was able to continue on with his research into the topic of vapor explosions, which was applicable to light-water reactors.

So after receiving his master's and doctorate degrees from MIT in 1976 and 1978, respectively, Corradini continued his investigations into reactor safety, returning to his boyhood home of Albuquerque to join the technical staff at Sandia National Laboratories. For the three years he was at Sandia, from 1978 to 1981, Corradini was the principal investigator for the NRC's LWR steam explosion research program, as well as an analyst for the NRC's Liquid Metal Safety Research Program and LWR Molten-Core-Concrete Research Program. At Sandia, he also participated in the Department of Energy's early research into the use of the Yucca Mountain site as a nuclear waste repository.

Back to Wisconsin

In August of 1981, Corradini returned to Wisconsin, this time to Madison and the University of Wisconsin, where he accepted the position of assistant professor in the Department of Nuclear Engineering and Engineering Physics (NEEP). Two years later he was tenured, and the following year he was promoted to full professor.

Corradini and son Nathan on a fishing expedition in Canada in 1992

Corradini was lured to Wisconsin by the well-known and respected nuclear engineer Max Carbon. It was Carbon who, in 1958, introduced nuclear engineering studies at UW, and four years later he was appointed chair of the newly formed Department of Nuclear Engineering (later NEEP), a position he held for a remarkable 34 years, until 1992. Still active as a professor emeritus, Carbon was elected to the National Academy of Engineering in February of this year.

Carbon, who felt his greatest responsibility as chair of the university's nuclear engineering department was to fill it with the best, most qualified faculty, actually started courting the young Corradini while he was still at MIT, calling him in 1978 to suggest that he join the UW faculty as an assistant professor. Corradini, having already turned down similar offers from the University of Virginia and Purdue University, as well as an industry job, turned him down.

The Corradini men gather in 2005. From left are Daniel, Stephen, Gregory, Nathan, and Michael.

During a 2010 trip, Corradini and his wife, Jan, enjoy the view from Corcovado in Rio de Janeiro, Brazil.

Plus, Corradini, eager to gain national lab experience, had already accepted the position at Sandia.

Carbon, however, didn't stop pursuing Corradini, who came highly recommended by his MIT instructors. Prof. Norman Rasmussen of MIT has called him one of the "top 5 percent of all graduate students I have known."

One technique Carbon used to lure Corradini to Wisconsin was to invite him to present seminars at the university. In a 1997 interview with UW officials, Corradini related how after one seminar in the fall of 1980, Carbon suggested that the coming new year would be a good time for Corradini to make the move to Madison. "By this time, I was ready to go to a university," he said. "That, combined with Max's persistence and interest, and the authentic 'family' atmosphere that Wisconsin showed, made it an easy decision."

Within the UW family, it could be said that Carbon was the father figure, but that notion took on a whole new and very literal meaning when Corradini married Carbon's daughter, Jan, in 1998. Aware of the irony of the situation, Corradini said he is often asked how it happened that he married his boss's daughter. It was, he said, Max Carbon's doing.

"The honest to God truth is that we were set up," he said. "He basically got us to call each other. Cleverly, I might add."

It's a story Jan verifies. "It's totally true," she said.

So with her father's express approval, Jan moved from her home near San Francisco to join Corradini in Madison. Corradini, who grew up as an only child, now has, together with Jan, seven children, ages 26 to 36.

For two parents with backgrounds in science and technology (Jan is a former nurse), the Corradini-Carbon children have taken a somewhat different path, with the bulk of them having pursued liberal arts degrees. Like their parents, however, they have excelled in their fields.

The oldest, Stephen, graduated with a degree in history and is now an executive for Whole Foods groceries. Gregory, who has a degree in journalism, works as a consultant for the National Oceanic and Atmospheric Administration writing analytical databases. Daughter Renee operated a stationery store and now works in real estate, while son Fletcher works for Altrec, an outdoor sports equipment supplier in Bend, Ore. Meanwhile, Daniel, another history major, does youth counseling and social work in Missoula, Mont., and the youngest, Marshall, currently works in retail in Madison.

The only one to take up the nuclear engineering mantle is Nathan, the second youngest, who has a bachelor's degree in nuclear engineering from UW and a master's in medical physics, also from UW. Nathan currently does radiation treatment and medical imaging at a clinic in Lugano, Switzerland.

When not traveling in the capacity of one of his many roles as a nuclear authority and researcher, Corradini relishes trips to visit his scattered offspring, if only to spend time with his five grandchildren.

Research and development

At UW, Corradini has continued his research into severe accidents and LWR design and safety. Most recently, it was announced in May that he will be working on an $871 119 DOE-funded project to experimentally validate an updated containment condensation model for small modular reactors (SMR), which will demonstrate adequate emergency core cooling. The work is being done in collaboration with principal investigator Qiao Wu, of Oregon State University, and Jose Reyes, of NuScale Power.

As a university professor for more than three decades and a former department chair (Corradini headed UW's Engineering Physics Department from 2001 to 2011), Corradini well understands the need for uni-

Four University of Wisconsin–Madison nuclear engineering department chairs gather at a department picnic in 2011. Joining Corradini (second from left) are, from left, former chair Gilbert Emmert, current chair James Blanchard, and former chair (and Corradini's father-in-law) Max Carbon.

Baby Gaia plays with Grandpa Corradini in 2009.

versities and research departments to continually seek out the federal grants and funding that are necessary to continue the work they do. Yet, in this time of constrained budgets, is the government providing enough funding?

"The obvious answer is that you can always use more," Corradini said. Yet within the last decade, despite shifting priorities among those holding the purse strings, Corradini said, "nuclear energy research has been, I think, fairly well funded." That said, given the recent recession and astronomical federal debt, Corradini sees in the coming years a reduction in funding across all energy sectors, not just nuclear. That means more competition for dwindling resources, a process that is "more political than it is rational," he said. "Let's just say, when you start cutting back available resources, various pieces of the pie fight with other pieces of the pie for what's remaining."

Going into that fight, Corradini identifies three priorities that deserve continued attention: sustaining the safety and reliability of current LWRs, developing SMRs, and addressing nuclear waste and the back end of the fuel cycle.

"I would say small modular reactors are important, but I think sustaining the safety and reliability of current reactors is actually more important," he said.

While noting the significant progress made in the past year by the DOE, the NRC, and the nuclear industry to address safety issues and delve into the lessons learned from the Fukushima Daiichi accident, Corradini said he would like to see continued efforts to improve reactor reliability and accident tolerance. "But that's an international program," he said. "That's not just the United States doing it by itself. It is collaboration and cooperation with the international community."

Likewise, in light of the recent recommendations of the President's Blue Ribbon Commission on America's Nuclear Future, Corradini said, we need to "start dealing with our spent nuclear fuel."

From his vantage point as a university professor, Corradini also has a good perspective on the supply of smart, qualified people being prepared to fill the human resources needs of the nuclear industry. While he admits that the situation was less than ideal about 15 years ago, he said there are now plenty of talented young people interested in nuclear engineering. This, he added, has happened pretty much organically, following the nuclear industry's renaissance. "Young people understand where there is opportunity and they move to it," he said.

But it has also gone beyond that, he said. Now, at most universities, including his own, in addition to nuclear power, students are showing greater interest in the medical applications of nuclear science and engineering, as well as in nuclear-related security issues. "All three of these, historically, are what nuclear technology is all about," he said, noting that all three areas—nuclear energy production, medicine, and security—have seen growing enrollments.

Leading through education

It's not surprising to learn that as an educator, Corradini intends to focus on education during his term as president of ANS. The importance of education and outreach, he said, has only increased in the wake of Fukushima.

According to Corradini, key to the Society's education and outreach efforts is the development of the Center for Nuclear Science and Technology Information. "CNSTI, to me, is the pivotal new piece that ANS has got to work on so that we properly educate and give the clear facts" to the public, he said.

Corradini said he sees four core audiences for CNSTI programs: middle and high school students, congressional leaders, the media, and the general public. The goal, he said, is to "get the CNSTI up and running, develop programs for all four of these audiences, and then, once a program is developed, institutionalize it so that as the years go by, we continue to provide factual information and improve upon how we do it."

Nap time for Corradini and Katie, the family's chocolate Lab.

As an example, Corradini pointed to a program called "Harnessing the Atom," which ANS is participating in with the help of the DOE. The program develops teaching materials on nuclear science and engineering that are aimed at middle school and high school students. Corradini said he feels that middle school students, in particular, are the appropriate audience for this program, as they are at the age when they are starting to think seriously about what type of career they hope to pursue.

In reaching the general public and media alike, Corradini sees the importance of coordinating with local ANS sections and getting involved in local issues, such as with the Vermont Yankee power station, where the local section is participating in educational outreach efforts to provide factual information to the public. "ANS headquarters is really helping the local sections to develop materials—factual materials—for these sorts of outreach," he said. "Again, another function of CNSTI."

Likewise, Corradini said that as part of CNSTI, ANS is sponsoring informal gatherings at the U.S. Capitol, inviting congressional staff to learn more about nuclear technology and related energy issues. These talks are primarily for the benefit of those leaders who do not have backgrounds in engineering or science.

In his own role as cochair of the ANS Special Committee on Fukushima, Corradini is contributing to the nation's dialog on the benefits versus the risks of nuclear power, speaking before Congress and the press, as well as giving public talks around the country. Corradini has been particularly satisfied with the results of these public talks, and said they have been very well received by the people attending them.

Many people who show up to the Fukushima committee talks are either ANS members themselves or students attending as part of a school group, Corradini said. He said that the group that comprises the general public is the most interesting, however, because many people come to the talks with few preconceived notions concerning nuclear power. For these people, when presented with the facts, "their rational decision making seems to take them in a direction many of us already feel," he said. "We don't try, or at least I don't try, to persuade them what direction to go. It's just a matter of presenting the facts and seeing what direction that takes them."

Corradini was visiting Japan in 1995 during the Kobe earthquake, and witnessing the effects of that earthquake firsthand gave him a deep appreciation for the degree and scale of the devastation caused by the Tohoku earthquake of March 11, 2011. For comparison, the Kobe earthquake was measured at a magnitude of 6.8 and took around 6400 lives, while the Tohoku quake measured 9.0 and, along with the resulting tsunami, resulted in approximately 20 000 people killed or missing.

"It's absolutely astonishing how large the devastation was," he said. Yet, despite the damage, he pointed out, no one died as a result of the partial meltdowns of Fukushima Daiichi Units 1–3 or the damage inflicted on Unit 4's spent fuel pool, nor does current evidence suggest there will be any substantial negative long-term health effects from the released radioactivity. "That's not to say we haven't learned anything," he said. "We've learned [a lot] on how to make the plants safer."

Corradini said that it is apparent that the nuclear industry is "very serious" about applying the lessons learned from the Japanese disaster, and that a combination of voluntary action on the part of industry and new NRC regulatory requirements will make plants safer. The question, he said, is determining which actions will be voluntary and which will be required. "That becomes a very difficult policy discussion that's going to have to be talked out between the industry and the regulator," he said. "It's not something that's obvious."

It is a discussion that certainly will be made more informed and insightful through the continued expert leadership of Michael Corradini. NN