Saxonburg Cyclotron
50th Reunion
By John Fetkovich

In 1946, Fred Seitz, then head of the physics department at Carnegie Tech, brought Ed Creutz (who later succeeded Seitz as department head), Jack Fox (who succeeded Creutz as department head), Roger Sutton (who succeeded Creutz as director of the Saxonburg Nuclear Research Center) and Bert Corben to Carnegie Tech to establish an important nuclear physics research program. Through a series of initiatives, a leading-edge 450 MeV proton synchrocyclotron was built at the Nuclear Research Center near Saxonburg in southern Butler County. The research program developed at Saxonburg flourished up to the mid-1970s when the then-obsolete accelerator was dismantled. The legacy of that work remains, in the form of vigorous, medium and high energy nuclear and particle physics research programs carried on by Carnegie Mellon groups at various national and international accelerator laboratories.

Carnegie Mellon last fall, attended by more than 130 ex-Saxonburg students, staff and faculty. The reunion was organized by a committee comprising Gale Pewitt at Fermilab; Tom Fields, Malcolm Derrick and Yanglai Cho at Argonne; and Joe Rudman, Joe Sadecky and John Fetkovich (chair) at Carnegie Mellon.

The festivities opened with a physics department open house on Friday. Saturday featured a series of talks relating to work done at the accelerator, and a reception and dinner. After dinner, talks by Fred Seitz and Ed Creutz (see page 4) told interesting stories about the early days of the accelerator.

On Sunday, participants were treated to a tour of the II-VI Corporation, which now occupies the old Nuclear Research Center site at Saxonburg. The tour was very generously personally hosted by Carl Johnson, chairman and CEO of the corporation, along with several employees. II-VI specializes in production of infra-red optical and laser components. Visitors were pleased to note that the original laboratory building remains, more or less intact, as does the old dormitory/cafeteria/lounge building, which is now used for storage. The most obvious changes are that the accelerator and attendant shielding are gone, along with the farmhouse and quonset huts: the high-bay area has been converted to three levels of office and laboratory space; and there has been considerable new construction, so that the original lab building is now but a fraction of the total facility.

The festivities were capped by a picnic lunch held in the Saxonburg Museum located in Roebling Park in Saxonburg, and hosted by Reidon Cooper, mayor of Saxonburg.

Scientific Discoveries at Saxonburg by Lincoln Wolfenstein

The Saxonburg cyclotron and a cyclotron at the University of Chicago had the highest energy pion beams in the world in the early 1950s. At Saxonburg, Julius Ashkin and collaborators measured the scattering of pions from hydrogen and discovered a resonance that proved to be the first excited state of the proton. At the same time similar experiments were carried out by Enrico Fermi in Chicago. When negative pions are stopped in matter a new kind of atom can be formed in which the negative pion circulates about the nucleus. Sergio De Benedetti and his collaborators measured the x-rays from these exotic atoms for a whole series of nuclei. These spectra provide a beautiful example of atomic physics in a new domain and also provide important information on the pion-nucleus interaction.
Graduation

The following seniors received bachelor’s degrees in physics at the May commencement:

- Michael Collins
- Benjamin Gatehouse
- Rodolfo Goetzblohm
- Brian Humensky
- Nicholas Kersting
- Hyunseo Koo
- Andrew Presby
- Terence Rokop
- Michael Seever
- Aron Soha
- Mark Sroka
- Andrew Steiner
- Keith Stitely
- Adam Tableman
- Jeffry Urban
- Benjamin Werle
- Thomas Whittaker

Master of science degrees were awarded to:

- Huajie Chen
- Cheng-Wei Chiang
- Krishna Chowdary
- Robert Feuerbach
- Nikolai Gouliaev
- Hwee-Kuan Lee
- Otto Linsuain
- Yi-Kuang Liu
- John McNabb
- Dan Qu

The following graduates received the degree of doctor of philosophy:

- Ralf Karl Heilmann (X-Ray Reflectivity and Diffraction Study of the Growth Dynamics in Quenched Xenon Films)
- Juan Carlos Pinto (Measurement of the B – B Oscillation Frequency)
- John Henry Scott (Morphology and Growth of Carbon Arc Nanoparticles)
- Dazhen Philip Sun (Biophysical and Biochemical Studies of Structure — Junction Relationships in Human Normal/Adult, Recombinant Mutant and Chemically Modified Hemoglobin)
- Jianming You (Measurement of the Hadronic Cross Section at the Z Resonance and Determination of Electroweak Parameters)

Honors and Awards

Since we reported to you last fall, the department has had a number of honors and awards bestowed upon it:

- Robert Sekerka, for contributions to the theory of crystal growth, and
- Michael Widom, for contributions to the understanding of quasicrystals, have been elected Fellows of the American Physical Society.

- Sara Majetich was named the 1997 winner of the Mellon College of Science’s Julius Ashkin Teaching Award. Sara has always been active in undergraduate research projects and has taught a broad spectrum of courses. Her laboratory is a haven for an active group of undergrads, grad students, postdocs and the occasional visitor.

- Hugh Young has won the 1997 Robert Doherty Award for excellence in education. It’s hard to imagine that anyone reading this column has not interacted with Hugh in some capacity: professor, friend, confidant, author, host, alumni ambassador. “Physics I with Hugh Young” continues to get great reviews! Many of Hugh’s contributions to the university over the years have been behind the scenes and with little fanfare.

- The Upsilon Chapter of Phi Beta Kappa has inducted the following physics department seniors: T. Brian Humensky, Nicholas Kersting, Aron Soha and Adam Tableman.

- The Richard E. Cutkosky Alumni Award was presented to T. Brian Humensky and Nicholas Kersting at the May commencement ceremony. This award is made possible annually by an alumni endowment; a plaque showing the names of all winners of this award now is on display in the chairman’s office.

- Freshman Cindi Dennis was awarded honorable mention in the Sigma Xi Research Symposium.

- Senior T. Brian Humensky was named a Carnegie Presidential Scholar.

- At the May commencement, the following graduated with honors: T. Brian Humensky, Nicholas Kersting, Andrew Presby, Aron Soha, Andrew Steiner, Adam Tableman, Thomas Whitaker.
Cosmic Expansion
An interview with Richard Griffiths and Robert Nichol

Our observational astrophysics group has expanded from one to three with the hiring of Richard Griffiths and Robert Nichol. Visit the group on the web at http://astro.phys.cmu.edu.

If the amateur astronomer in you has ever been amazed by the brilliance of the night sky, thrilled by the beauty and power of the images from the Hubble Space Telescope, or wondered at the origins of the universe, then you can appreciate the work being done by a new cadre of experimental astrophysicists at Carnegie Mellon. Professor Richard Griffiths, who recently joined the Physics Department’s experimental astrophysics research group, is in charge of the Hubble’s Medium Deep Survey, a key project charting thousands of galaxies. Adding further excitement to this growing research area is Robert Nichol, who joined the department this winter as an assistant professor.

Together with astrophysicist Jeff Peterson, Carnegie Mellon’s astrophysics group is interested in getting access to observational research time on the Hobby-Eberly Telescope, a new large astronomical telescope currently nearing completion at McDonald Observatory in a remote part of west Texas. They also are keen to becoming partners in a copy of this telescope that will be built in the southern hemisphere and are in the midst of planning an aggressive fund-raising campaign to do this.

Individually, their research spans the galaxy and beyond. Griffiths watches the skies through the eyes of Hubble and through x-ray telescopes in Earth orbit. Nichol is a collaborator in a major new survey of the sky using a dedicated telescope at Apache Point, New Mexico. The project is called the Sloan Digital Sky Survey — and will be the first major survey of the sky since the National Geographic/Palomar Sky Survey in the late 1940s. Nichol uses remote access to the telescope in New Mexico to study the origins of the universe.

Both are also actively involved in sorting out and briefing up student courses in observational astronomy and are taking on student research partners who can help create WWW sites and look at the vast amounts of observational data that the researchers are using.

Richard Griffiths: The Medium Deep Survey with the Hubble Space Telescope

When asked how many galaxies he has discovered through research, Griffiths laughs and reports that he has stopped counting. But even after finding tens of thousands of new galaxies, he continues to be amazed at the wealth of data coming back from Hubble.

"The images of thousands of galaxies taken from the wide field camera are being used to unravel the origin and evolution of galaxies, from giants like the Milky Way, to the much more numerous dwarf galaxies," he says.

For Griffiths and others, the Hubble Space Telescope proves true to its promise to expand greatly our knowledge of the universe. The Medium Deep Survey, now in its sixth year, has led to more than 50 scientific publications for Griffiths and his research team, as well as numerous NASA announcements of their discoveries.

In the Medium Deep Survey, Hubble uses its wide field camera to search for unexpected objects in uncharted areas of the sky while another Hubble instrument conducts primary observations of different celestial targets. Pictures are taken in multiple wavelengths, including ultraviolet, visible and infrared.

These images, gathered in parallel, enhance our understanding of the origin and evolution of galaxies. They are among the wonderful visuals now being shown on television, published in magazines and written about in academic journals.

If the rewards of Hubble research are the discovery of the previously unknown and the unexpected, then Griffiths and his research team have been rewarded many times over by the data collected. The fabulous pictures and information sent back by Hubble’s Medium Deep Survey provide hints about the building blocks of the universe.

For example, this serendipitous survey of the heavens uncovers remote and unusual galaxies never before resolved by optical tele-

(continued on page 7)
Not in My Football Field
by Ed Creutz
(talk given at the Saxonburg Cyclotron 50th reunion)

Looking over the plans. Left to right: Ed C. Creutz (Physics), Carl C. Monrad (Head, Chemical Engineering), Robert E. Doherty (President, Carnegie Tech), Webster N. Jones, (Dean, College of Engineering and Science), R.F. Mehl (Head, Metallurgical Engineering), John C. Warner (Head, Chemistry)

The year 1946 is the right time for a 50th anniversary of the start of the nuclear physics at Carnegie Institute of Technology, for it was early 1946 that Fred Seltz, then head of the department of physics, began to plan for a program in that rapidly growing field.

Only 10 years earlier, important physicists, including Ed Condon, predicted that the excitement of physics was on the wane, since the two great theories of relativity and quantum mechanics might clear up all the basic problems, even though the two theories could not yet be combined to fully describe gravitation, nor can they even today.

But during the next few years new data from cosmic rays and from laboratory-based accelerators indicated that there was more to the structures of matter than meets the eye, even when the eye is aided by precision atomic and nuclear spectroscopy.

With the discovery of fission by Hahn and Strassmann in Germany in 1939, and the increasing use of accelerators, a significant fraction of the world’s physicists turned their attention to the nucleus. Immanuel Estermann, whose seminal work with Otto Stern had used molecular beams to measure nuclear spins, was the only one at Tech who had chipped away to see what was underneath the electron shells of atoms. And Fred, besides his own essential work on the Manhattan Project, foresaw the growth of nuclear physics as a significant part of the education of physicists. He obtained the support of Robert Doherty, president of Carnegie Tech, to move decisively into the new field. He hired Bert Corben, who had done early work on looking for a unified field theory, and experimentalists Jack Fox, Roger Sutton and me.

In 1946 many nuclear physicists thought the best way to tackle the questions of nuclear structure was to study in detail the energy levels of a wide variety of nuclei. A number of moderate energy electrostatic accelerators were to be under construction for this purpose, and we at first considered a rather modest model, of 15 or so MeV.

But great excitement was building because of the discovery of mesons in the cosmic rays as a possible key to understanding nuclear structure. The mu meson didn’t really seem to fit current nuclear ideas, since it had the wrong spin and a strange mass, but that was the only meson clearly identified at that time.

Fred went to the Office of Research and Invention of the Navy, soon renamed the Office of Naval Research, whose programs in solid state physics Fred had helped considerably to develop, and asked for funding for a synchro-cyclotron to accelerate protons. In quick succession Fred secured promises of support from the Buhl Foundation, a local philanthropical group, and from Westinghouse. Westinghouse offered a gift of the former KDKA transmitter building and 50 acres of land at Saxonburg.

We planned a program with some first-class graduate students, including especially Martyn Foss, who had been a key member of the staffs at the Metallurgical Laboratory at Chicago and at Los Alamos during the war. Dave Rose, Dave Brower, Rolf Winter and others. We found an excellent mechanical designer, Henry Berman, and an outstanding draftsman, Margaret Trimble, now Peg Lees. Later an electrical engineer, Dick Ankersen, joined us.

The magnet designed by Martyn Foss was indeed unique. His method was to shape the pole-pieces very carefully to get the most of every pound of steel, and to design very compact coils. Our closest competitors for big cyclotrons those days were the University of Chicago and Columbia University. Foss’ design used 1,500 tons of steel, while those of our competitors used upwards of 2,000 tons and produced protons of no higher energy. Foss also was principally responsible for the radio-frequency oscillator system and other key components.

The precision required by Foss’ magnet design led to some interesting adventures. We asked that the pole pieces be kept within tolerance of five thousandths of an inch, and that the steel be free of slag and other imperfections. When the machining was in its final stages, a small region of porosity was discovered. We decided that the porous material could be drilled out and the cavity filled with a steel plug. A plug was prepared, cooled in liquid nitrogen to shrink it slightly, and inserted in the cavity. To ensure that it was well seated, a husky man stood above it, armed, with a sledge hammer. I couldn’t avoid wondering what would happen if he missed his target, and made a new dent in the pole piece. He did. But fortunately the scar could be machined away.

Two very important people were Jim Thompson and Homer Collins. I don’t know whether they would prefer being called precision machinists or design engineers. They were clearly both. Many details of the cyclotron that required special excellence were due to their careful work.

We therefore decided to have the coils wound at the Brooklyn Navy-Yard. They were completed in early spring, and the plan was to ship them by barge from New York to the Erie Canal, through the Great Lakes, to Lake Erie, and truck them to Saxonburg. Unfortunately the spring was late and the Erie Canal was frozen over when the coils were ready to be shipped.

We had originally contemplated shipping the coils by rail, but only the available flat car in the country, of sufficient size and load-carrying capacity, was tied up for six months. Because of the unusually wide load, in excess of 20 feet, the railroad surveyed the route and ground only one interference, where a sign post intruded on our required right-of-way by 3/8 inch. This was corrected by a hacksaw. But

(Continued on page 8)
Viper Telescope Unveiling Ceremony

Professor Jeff Peterson and his team completed construction of the Viper telescope in August 1997. The telescope was immediately shipped to Antarctica where it will detect cosmic microwave remnants of the Big Bang. (See related article in Interactions 1996 at http://info.phys.cmu.edu)

Top left: The assembled telescope behind Doherty Hall.

Bottom left: KDKA news reporter Bill Flanagan interviews Peterson.

Bottom right: Peterson's research group and the telescope during the unveiling ceremony.
Undergraduate Physics Curriculum

By Reinhard Schumacher

Reinhard Schumacher chairs the undergraduate curriculum committee. His physics research is in the area of medium energy experiment.

Every former and present undergraduate physics student remembers the experience of getting an official Course Catalog and looking up the curricular requirements for his or her major field. There were required courses in physics, required courses in related areas such as math, chemistry and perhaps biology, elective courses in physics and other technical fields, and finally an array of distribution courses in outside areas such the humanities. More often than not, students find the requirements and options confusing and daunting at first, but accept them as simply part of the given university academic system. Who makes up all these rules and requirements? Do they ever change, and if so, for what reasons?

The Physics Department has an Undergraduate Curriculum Committee whose task is to monitor how our curriculum meets our educational goals, and to consider how the undergraduate academic experience might be improved. This group is responsible for maintaining the flow and continuity of the sequence of courses our majors take, against a shifting landscape of university mandates, available teaching manpower and student interests. Within the past three years the most important changes we instituted resulted from a university-wide change in policy concerning the Introductory physics courses. In the near future, the main anticipated change will be the addition of new astrophysics courses.

Consider how the seemingly immutable curriculum experienced by undergraduates is actually quite fluid when viewed on a timescale of more than four years. In 1994 the engineering college reduced the number of physics courses taken by engineering students from three to two. A year later the science college followed suit. This upset a long-standing sequence of three courses offered by the department: Physics I (Newtonian mechanics including rotations and angular momentum), Physics II (waves, vibrations and optics for half the semester and thermodynamics for the other half) and Physics III (electricity and magnetism up to Maxwell's Equations). We had to devise a pair of two-semester sequences for the engineering and the science students which in some way covered the ground previously covered in three semesters. The "third" course would be required only for physics majors. Note that in former times, more than 20 years ago, all students took four semesters of introductory physics — how times have changed. The challenge was to determine what the content of the new courses should be, such that the non-physics majors would receive respectable introduction to the subject, while the physics majors would reach a level of understanding sufficient to undertake their intermediate level courses.

We agreed not to simply compress three semesters of physics into two. Some topics, agonizingly, would have to be deleted from the old sequence. We wanted a third course for physics majors that would not just fill in topics omitted from the first two courses, but give these sophomores a first look at 20th-century physics. A great deal of discussion followed, since everyone on the committee, not to mention every other faculty member in the department, had his or her own ideas about what the introductory sequence should contain. Starting in the fall of 1996 we fully implemented the results of our efforts. Physics I now treats basic Newtonian Mechanics plus several weeks of thermal physics. Physics II is now mostly electricity and magnetism, as well as a few weeks of wave motion. Both of these courses exist in versions for the science students and for the engineering students. While their syllabi are very similar, instructors are free to make adjustments according to which group they are addressing.

Physics III received the largest makeover in this process. Substituted "Modern Essentials," the new course consists of Special Relativity and early quantum phenomenology, finishing with the Schrödinger equation. The virtue of teaching SR to sophomores is that it challenges people's conceptions of space and time, but in a context that can be kept mathematically simple; we find that this approach captures and holds people's interest. The virtue of bringing quantum physics into the curriculum early is similarly to give young students a chance to deal with non-classical, initially non-intuitive, topics early enough to keep their interest in the subject high. Our response to this course offering has been very good. Although only required for physics majors, over half the enrollment in each semester has come from other areas of the university.

To compensate for the loss of several topics in the introductory mechanics course, we made another adjustment in the early curriculum, adding a course to be taken in parallel with the Modern Essentials course. Called Physics Analysis, this course deals with simple harmonic motion, using it as a vehicle for solving the relevant differential equation in many different contexts. We introduce numerical modeling and symbolic manipulation using the Maple computer program. Thus the physics majors still have four courses at the introductory level to prepare for their intermediate level course, just as in former times.

In the next two years more changes will likely occur in our curriculum. Our strong new Astrophysics group will introduce two new courses at the introductory level: one is an introductory astronomy course for all students, including non-technical students, while the other is an experimental astronomy course for technical students who wish to learn the craft of using astronomical equipment. We believe there is large pent-up demand for courses of this kind at Carnegie Mellon. The undergraduate curriculum in physics is hardly a static entity. The department is continually looking for ways to better serve the needs of its students.
Cosmic (continued from page 3)

scopes. Some of the remote galaxies lack the familiar spiral and elliptical shapes characteristic of galaxies in the nearby universe. One cosmological model suggests that galaxies in this early universe interact dynamically and grow bigger by cannibalizing smaller regions in star formation. If that theory is true, says Griffiths, then the objects he and his research team found may be building blocks for today's larger galaxies.

In 1995, Griffiths and the international team of astronomers from the U.S. and Britain that are part of the Medium Deep Survey shed new light on one of the most puzzling, long-standing mysteries of extra-galactic astronomy. The survey team reported that our universe is dominated by small, highly distorted galaxies with a strongly irregular appearance. Previously, astronomers believed that giant spiral galaxies like our own Milky Way dominated the vast volume of space.

Griffiths brought an entire research team, including Senior Research Scientist Kavan Ratnatunga, to Carnegie Mellon. Here, they'll be furthering their Hubble research and also looking at data collected from Griffiths' work in x-ray astronomy.

Griffiths began his research in the field of x-ray astronomy and he continues to work on the origin of x-ray background from space, using data in the form of deep images taken with earth-orbiting x-ray telescopes. With images from these x-ray satellites, he and other researchers use some of the world's largest optical telescopes to identify the kinds of galaxies that are the greatest producers of x-rays.

Robert Nichol: Robotic Telescope Brings the Skies to His Desktop

A fundamental question facing cosmology is: How did the rich, complicated structure we see locally form and evolve from the earlier smooth, hot Big Bang? Observations of the universe play a crucial role in answering this question.

Nichol, who like Griffiths hails from Wales, explores the origins of the universe by performing remote astronomical observations using a robotic telescope in New Mexico.

"I observe once or twice a month using the Internet and a computer (Mac) in my office," Nichol says. "My part in this endeavor is the study of cluster of galaxies as a function of cosmological look-back in time. Present technology allows us to reach back to approximately half the age of the universe."

Meanwhile, Nichol eagerly looks forward to the completion of the next generation of cosmological observatories. New 8-meter optical telescopes, upgrades to the Hubble Space Telescope, and new x-ray and microwave satellites will allow astrophysicists like him to extend this work to even earlier epochs in the universe.

Complementing these efforts will be the Sloan Digital Sky Survey (SDSS), which will comprehensively map the local universe. Nichol is an active member of the SDSS, which will start taking in data this year. The goal of the SDSS is to produce a detailed digital photometric map of half of the northern sky to the 23rd magnitude.

Nichol describes SDSS as the "next generation of surveys" and says it is the "biggest, most ambitious project in ground-based survey astronomy" to date. By using a new imaging technology called a charged-coupled device, invented by Bell Labs, SDSS will be able to chart the skies at a rate 100 times faster than the old photo plate process.

"We're expecting 100 million objects in our database. The scientific value of such a data set is tremendous," Nichol says.

"Applications of the information can range from critical investigations of large-scale structures in 3D to the relationships of galaxies with their environment, to the faint-end luminosity functions of disk dwarf stars."

The survey is being done by researchers from many institutions, including Fermilab, the University of Washington, Johns Hopkins, Princeton and the University of Chicago, where Nichol was before coming to Carnegie Mellon.

Nichol says that copies of the Sloan data will reside at Carnegie Mellon and be available to students.

Nichol is eager to share his excitement with Carnegie Mellon students.

"I had originally planned to go into film directing but ended up in physics instead. A professor took me observing and I loved every minute of it. I'm eager to share this experience with Carnegie Mellon students."

"I plan to construct large, objective catalogues of clusters from this database, which will then require detailed observational follow-up using next generation telescopes. My students and I will travel to international telescope facilities in Hawaii, Chile and Australia to carry out our observations."
the delay in obtaining the flat car was intolerable.

We therefore reluctantly decided to ship them by ocean barge from New York, around Florida to New Orleans. There they would be transferred to a river barge, a different kind of animal, brought up the Mississippi River to the Allegheny River, then to Freeport, a site about 20 miles from Saxonburg, from where they would be trucked to Saxonburg.

Before Westinghouse so generously offered us the former KDKA transmitter site at Saxonburg, we of course thought a lot about where to build the cyclotron. Attractive to us was a football practice field on campus near the physics department.

Before embarking on the cyclotron project, the dean of engineering and science called a meeting of the faculty to get their views on such a new and large undertaking. Most faculty supported the new plan. More cautious were some of the chemists, who felt the school was not ready to jump into big science. It was clear that, to some, a football field was a more welcome neighbor than a cyclotron. Thus the gift of the Saxonburg site was most welcome. One chemist, Truman Kohman, later used the cyclotron in his discovery of aluminum 26, soon an important-tool for studying the history of the solar nebula, from which the planets formed.

Before the cyclotron was ready we made use of the University of Pittsburgh 12 Mev deuterion cyclotron, thanks to Alex Allen. Bernie Cohen was our first student to do his thesis work there. Other graduate students helped in our cyclotron design work. Rolf Winter worked on precision test of our unusual magnet.

The first published paper using the cyclotron beam was that by Don Grove and Jack Fox, showing the relationship between mass and velocity for relativistic protons. Although this was well known for electrons, and agreed with Einstein’s theory, it had not been directly measured for heavier particles. Major topics to which the staff and students contributed were proton-proton and neutron-proton scattering, as well as meson behavior, including mesic atoms, those strange beasts where an electron in an atom is replaced by a meson. Sho Koo Kao specialized in using the new photographic plates to follow the paths of mesons and observe their collisions with nuclei. He made for me a 20,000 times enlargement of one such path, which still decorates a wall of my living room.

As new staff joined the department, several became interested in the cyclotron work. Julius Ashkin extended his mostly theoretical work to experiments. Lincoln Wolfenstein, who may possibly finally have his long-sought neutrino mass, was an important addition. Sergio de Benedetti came to us from Oak Ridge, and brought his technique of measuring time to a billionth of a second, and held classes in his home on the new field of quantum-electrodynamics.

Others who participated in the nuclear program were Donatella Baroncini and Felix Adler. Felix was the son of Friedrich Adler, whose opposition to World War I had led to his fatal shooting by the Prime Minister of Austria in 1916. It is interesting to speculate what emotion Felix must have felt in helping to develop a new world of international science shortly after the second world war.

Gian-Carlo Wick, who came to us in 1950, was one of the scientists at Berkeley who refused to sign a special University of California loyalty oath. He explained that he had already signed a State Oath, and felt that further oaths were not of deep significance after the first.

Visiting professors who came for academic year periods during this time included Christian Becker and Siegfried Flugge from Germany. Becker liked to say that his principal contribution to physics was that he invented Eugene Wigner, who had indeed been Becker’s student. Flugge was the first German physicist to calculate closely the critical mass of an assembly of uranium 235.

When the machine was nearly ready, Charles Wilson, the Secretary of Defense, visited. After I carefully explained to him what the cyclotron was and why it was important, he leaned back in his chair, opened his coat, and said, “See this shirt. It’s nylons.” I guess he wanted to show that he too was participating in the new science. I had expected him to ask if fast protons would make good bullets. In fairness I must say that Wilson had come to Pittsburgh for other purposes and the cyclotron visit was an afterthought.

Leo Szilard visited shortly after the massive concrete shield was assembled. He shook his head and said, “Creutz, you have built the tomb of science.” But perhaps phoenix-like, after our unfortunate loss of Seitz and his principal co-workers in solid-state physics, there arose a new era of nuclear physics in Pittsburgh.

Saxonburg is the site where the Reoibling brothers assembled the cables for the Brooklyn Bridge. The main street was originally a rope walk where strands of rope or steel were laid out and twisted by machine to make heavy cables.

Saxonburg was known for a product that, in its own way was almost as potent as the cyclotron. This was grown by the owner of the Saxonburg Hotel and was his own special brand of horseradish. I once had a dinner meeting with some non-physics Carnegie Tech staff at the hotel before we visited the cyclotron. Their memories later were filled at least as much by the Saxonburg horseradish as by the Saxonburg protons.

You have noticed that I mentioned several people by name tonight. Many other people who made truly significant contributions to the cyclotron program I have not mentioned. Please don’t think that your work was not appreciated.

The true monument to all of you and to the loved ones who have left us is the work you did together, and not just the few things you have heard about today. Thank you all for being part of it.
calculate nuclear energy levels. A subsequent article in Reviews of Modern Physics became one of the most cited articles in that journal’s history. Because of contacts made in Copenhagen, Sorensen was subsequently able to recruit Peter Barnes in nuclear experiment and Len Kisslinger in nuclear theory to join the Carnegie Mellon physics department, forming what continues to be a very successful research program.

At Carnegie Mellon, Sorensen worked with a succession of Ph.D. students and postdoctoral associates applying methods of pairing correlations and other collective effects. During a leave in Stockholm at the Atomic Physics Institute, he was present at the discovery and initial study of super-deformed nuclei. These rapidly spinning nuclei are produced in collisions of heavy ions. Sorensen was co-organizer of two international conferences, and associate editor of Nuclear Physics A.

In addition to calculating nuclear phenomena, Sorensen has made serious efforts to make simple explanations of advanced physics. He has published articles in American Journal of Physics (the “physics teachers journal”) on topics such as the Magnetic Hyperfine Anomaly and the Lorentz Contraction. With Michel Baranger he wrote an article in the popular journal, Scientific American, about the size and shape of atomic nuclei. Sorensen taught courses at all levels from college freshman to graduate student. One introductory course was the combined Physics-Calculus course taught jointly with the math department. The needed math was delivered “just in time” as needed for physics applications, and the physics was used to help students visualize the mathematics.

Ray’s colleagues at Carnegie Mellon wish him and his wife, Audrey, all the best in their retirement.
Alumni Corner

What I Got Out of Physics...and How

By Bob Englemore

Bob Englemore received his B.S. and Ph.D. degrees in physics from Carnegie Mellon University. He is senior research scientist and executive director of the Knowledge Systems Lab, an artificial intelligence research laboratory within the Department of Computer Sciences at Stanford University.

Last October, before the Homecoming Weekend, I gave a talk at the undergraduate physics colloquium on the opportunities and adventures of an ex-physicist (me). Although the talk was mostly autobiographical, I wanted to deliver two messages to the students, who may well be concerned about their future in today's job market. The first is that unexpected opportunities arise every now and then in one's life, and, in my experience, seizing those opportunities leads one down interesting, productive and satisfying career paths. Or, to quote the whimsical Yogi Berra, "When you see a fork in the road, take it."

As a physicist I switched from the research I did at Carnegie Tech on neutron transport theory to computational physics applied to ballistic missile defense problems. After nine years as a computational physicist simulating the effects of nuclear weapons used to defend against ballistic missiles, I left physics and took up artificial intelligence research at Stanford University, where I worked on a variety of applications of AI problem solving methods. I then took a two-year leave of absence from Stanford to serve as a program manager at DARPA, after which I joined a startup company that developed expert systems, and then returned to AI research at Stanford, where I am today. I also had the opportunity to be the editor-in-chief of AI Magazine, a position that I held for 10 years. I have never regretted giving up what I was doing to explore these new avenues as they were presented to me.

The second message was that no matter what road you take later in life, your education as a physicist is an excellent preparation for a professional life either in or out of physics, particularly if your subsequent career requires solving problems (and what career doesn't?). A physics education gives one not only a knowledge of the behavior of the physical world, but more importantly the ability and sense of confidence to take on, analyze and frequently solve a wide variety of challenging problems in biology, medicine, engineering and information processing, to mention a few. After leaving physics and entering computer science, I worked on a variety of applications, including organic chemistry, protein crystallography, structural analysis, problem-solving architectures, computer configuration, device modeling, among others. I probably would have backed away from many of these applications if I hadn't developed the problem-solving skills that I learned as a physics student. In some areas, my physics background was directly applicable. In developing a system to elucidate the structure of proteins from x-ray crystallographic data, it was necessary to understand the physics of diffraction and the mathematics of Fourier transforms. However, in other domains, I used the basic heuristic of decomposing a problem into simpler parts, rather than use any specific physical principles (e.g., a system to advise coffee blenders).

I will always be indebted to Carnegie Mellon and to the teachers who prepared me for this world. I was particularly inspired by the lectures of Julius Ashkin (quantum mechanics) and Simeon Friedberg (thermodynamics), and deeply appreciate the support from my thesis advisor, George Hinneman (who also taught me to play Go and helped me find my first job). And I recall taking a course in experimental methods from an enthusiastic graduate student named Hugh Young. I never had much interest in experimental physics, but I'll never forget one summer spent at the Saxonburg cyclotron lab calculating orbital trajectories with an analog computer, and once I even crawled inside the cyclotron magnet with a flip coil to measure the field! Beyond the Physics Department I owe a great debt to William Schutte, in the English Department, who taught a creative writing course that I took in my freshman year. He taught me how to communicate clearly, accurately and precisely. That skill has served me well in every endeavor.

Alumni News

Walter Roscello Jr. (B.S. '90) left his job with the Navy and took on a position created for him at the University of Chicago Medical Center. He works with doctors, physicists and medical physicians on creating 3-D images from x-rays, MRI and CAT scans for use in cancer treatment. Walter lives in a 104-year-old Victorian house in Chicago's Hyde Park, together with his wife, Zoa Conner (see below), and their cat, Zelda.

Zoa Conner (B.S. '91) went to graduate school in physics at U of Maryland on a prestigious National Physical Science Consortium Graduate Fellowship. She became the first student from the U.S. to join the "Super-Kamiokande" experiment in Japan, which evolved into the world's premiere neutrino observatory and proton decay experiment. Zoa worked on almost all aspects of the experiment that required frequent extensive travel to Japan, as well as travel across the U.S. to collaboration meetings. She is now at U of Chicago on a Robert McCormick Postdoctoral Fellowship. She has begun to work on STACEE, an atmospheric

(continued on page 11)
Alumni News (continued from page 10)

Cherenkov detector that will study Active Galactic Nuclei and other sources of high-energy cosmic radiation.

Raymond W. Schmitt (B.S. '72), now a senior scientist at Woods Hole Oceanographic Institution, received a Guggenheim Fellowship to study double diffusive convection and oceanic mixing.

Barry Holstein (B.S. '65; Ph.D. '69) wrote his thesis on weak interaction theory under the direction of Lincoln Wolfenstein. After a two-year postdoc at Princeton he accepted a position at the University of Massachusetts at Amherst where he is now professor of physics. He has lived in Amherst since, except for a two-year stint at the National Science Foundation as well as time spent in visiting positions at Princeton and at the University of Washington. He is a Fellow of the American Physical Society and was recently awarded a Humboldt Senior Scientist Research Fellowship under which he will spend a year at Kernforschungszentrum Jülich, Germany. He has published numerous papers as well as three books, one of which — "Topics in Advanced Quantum Mechanics," Addison-Wesley (1992) — is strongly influenced by material learned during his time at Carnegie Mellon and is dedicated to the memory of former physics department member and department head Julius Ashkin.

Paul A. Medwick (B.S. '88) completed his Ph.D. in applied physics at Cornell University in 1994. His dissertation work involved the study of glass-like excitations in bulk solids and thin films. During graduate studies he was an IBM Fellow in the Physical Sciences and a U.S. Department of Sciences and a U.S. Department of Education for National Needs in Materials Physics Fellow. Paul is now a senior development physicist with PPG Industries, Inc. in the Vacuum Coatings Group at PPG's Glass Technology Center near Pittsburgh. His present work involves research and development of multilayer optical thin films for fenestration applications. He is a member of the American Physical Society, the Materials Research Society and the Society of Vacuum Coaters.

Hugh Pendleton (B.S. '56; Ph.D. '61) is a professor of physics at Brandeis University. He is a participant in the Philosophy and History of Science Workshop. Hugh has been a member of the Faculty Senate for the last five years, and its chair for two of them. Hugh has been pondering string theory and teaching the occasional course on it for the last 20 years, and wants to "put the fruit of those ruminations on a website."

Tell us about yourself!

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