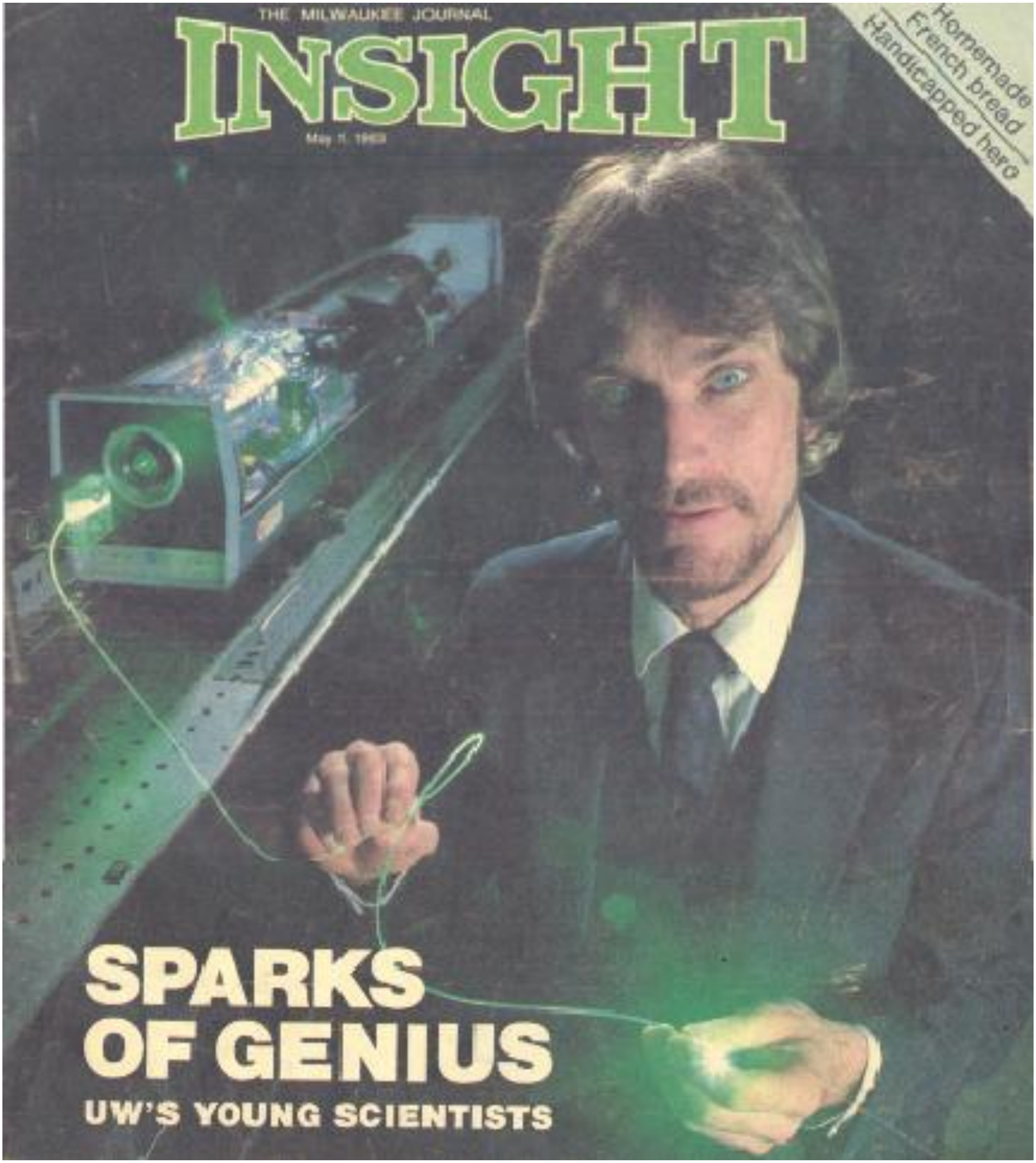
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UW'S YOUNG SCIENTISTS

BRIGHT LIGHTS IN SCIENCE

Top-notch young researchers add luster to UW's reputation

Story by Jeff Browne, photography by Michael Sears

THEIR peers consider them some of the world's most promising young scientists. Given generous financial support, the right opportunity and luck, one or more of them might be capable someday of winning a Nobel Prize.

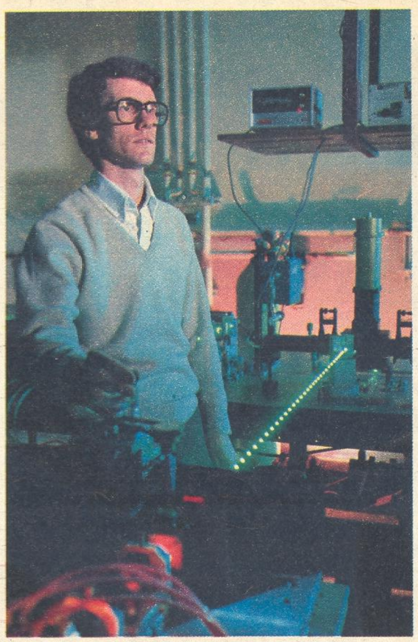
You've probably never heard of them, but the seven are either world-class scientists or potentially worthy of such status. And they're in the University of Wisconsin System — six at Madison, one at Milwaukee.

Their futures are bright. Yet the immediate goals of these scientists do not seem strikingly spectacular. One, for instance, wants to understand the genetic makeup of a single virus. Another explores the changes within a molecule in a few *billionths* of a second.

In some cases, their work is so esoteric that Robert Bock, dean of the UW — Madison Graduate School and himself a scientist, is hard-pressed to explain it.

Although the young researchers enjoy wide respect, they earn, on the average, a modest $31,007 a year. A different kind of currency matters most to them.

"Results are the currency of science," says one of the seven, UW — Madison chemist Fleming Crim.



Typically these scientists spend 60 to 70 hours a week paying attention to minute details and infinitesimally small quantities of time, matter and energy.

Their value to a university is considerable. A great research university is like a house of cards. Extraordinary scientists anchor academic departments, acting as the glue that holds the fragile institution together. They serve as magnets, attracting the brightest colleagues and top graduate students.

The best scientists also bring in the biggest bucks. Of these seven scientists, for example, each controls an average of $225,446 in grants from federal agencies, the military, foundations and corporations. The money buys scientific equipment and pays for such things as travel, research and the salaries of research assistants.

All seven — five men and two women — are in their 30s and represent imported talent. Two were born in other countries, five in other states. In each case, Wisconsin's universities attracted them.

These seven, of course, are not Wisconsin's only extraordinary young scientists. They are featured here because they represent a variety of scientific disciplines — from mathematics to microbiology — as well as various stages of development. The bulk of their careers, presumably, still lies ahead.

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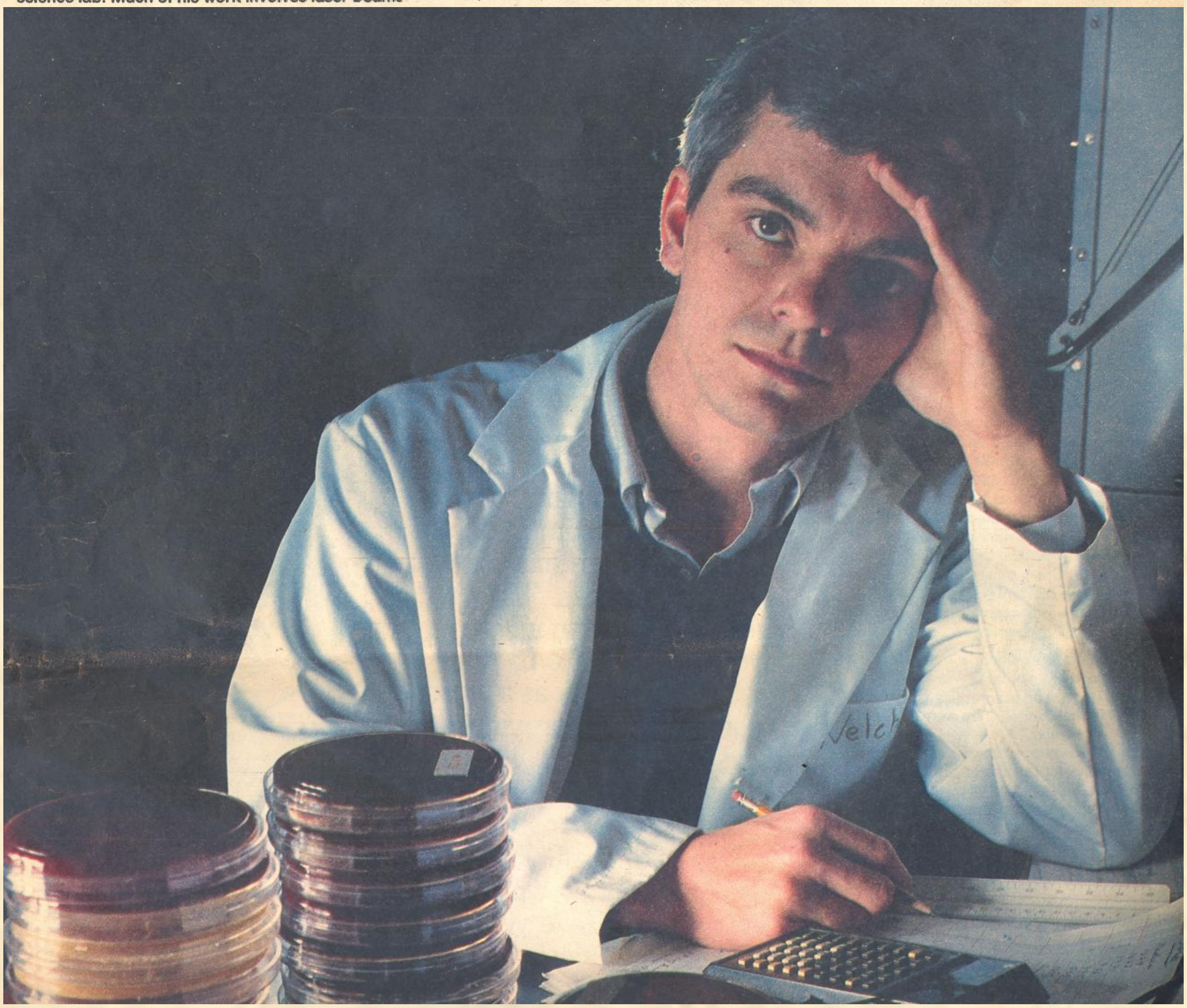
Behind a cluster of petri dishes, University of Wisconsin — Madison microbiologist Rodney Welch delves into a research problem. Like Welch, UW chemist Fleming Crim (above) often spends six days a week in the science lab. Much of his work involves laser beams



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Probing the Mu virus

NOBODY is better acquainted with the Mu virus than UW bacteriologist Martha Howe. The virus is so rare it has been found only in lab cultures of bacteria. Scientists consider it significant because its properties may provide clues to the functioning of cancer-causing organisms.

The Mu contains a head and a tubular tail with six fibers at the end. The tiny virus uses the fibers to latch onto a single-celled organism, a bacterium, which, by comparison, is a hulking giant. The virus deposits its genetic contents into the bacterium and begins replicating itself. The bacterium is conquered, and hundreds of Mu viruses are born.

Howe focuses her attention on this microscopic battle between the Mu and the bacterium.

She wants to know, down to the last genetic detail, precisely how the Mu works. In this quest she explores the ultimate problem of the science of life: How is a gene controlled? (Genes are those basic units in cells that transmit hereditary characteristics.)

"That is the answer to just about everything," she says. "Genes turn on and off to do things they are supposed to do."

By getting down to the gene level, scientists can study how the Mu's characteristics are activated.

Howe's research is still a few steps removed from medical advances. Though the Mu is not known to be harmful to humanity, Howe and others feel that progress in understanding how the Mu works ultimately may contribute to advances in cancer control.

Perhaps further in the future, Howe's work might be applicable to even more spectacular discoveries — such as control of fundamental human processes. Control of genes, for example, raises the question of whether the process of aging can be modified.

Howe's work is watched closely.

Says geneticist David Botstein of the Massachusetts Institute of Technology: "It is no exaggeration to say that the entire field (of molecular biology) has come to depend upon Martha and her co-workers to provide basic information about the genetic map of the (virus) and in the characterization of its genes."

Howe, 37, grew up in North Carolina. She earned an undergraduate degree from Bryn Mawr College in Pennsylvania and a doctorate at MIT.

She was married as a graduate student, later divorced and now is single. Few women, she says, can excel in a scientific career and also raise a family.

"It takes a very large personal commitment to have any academic career," she says. "It takes a lot of the person."

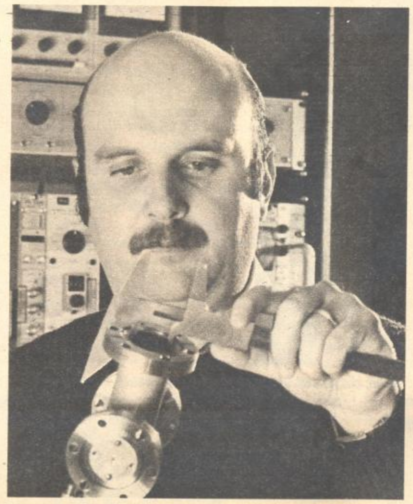
Howe is intense but friendly. She works six days a week, often late into the night — a total of 60 to 70 hours a week.

"There is no other way I could do the teaching to the level of quality that I want, the research to the quality that I want, and professional activities," she explains.

Her curriculum vita is longer than some master's theses: 27 pages, single-spaced. Even so, UW administrators think Howe's greatest contributions lie ahead — in Wisconsin, they hope.

"I have a great loyalty to Wisconsin," she says. "I certainly have found a home I like. I think it is unlikely that anybody else (another university or industry) could come up with a combination of features that would be more attractive."

Jeff Browne has been a Milwaukee Journal education reporter since 1976. This month he will become an assistant editor of The Journal's metropolitan desk.



Rome-educated Georgio Margaritondo does pioneering research in solid-state physics.

Pushing the limits

IN THE UW's vast domain of scientific laboratories, precautionary signs abound. Each lab, it seems, displays one or more danger signs: A radioactive substance here, laser beams there, high voltage, recombinant DNA and explosive chemicals elsewhere. The door of one physics lab contains a warning of a different kind. It says: "Mafia Member; Watcha U Mouth."

Inside the office sits Georgio Margaritondo, a balding, personable, stocky physicist with an Italian accent and the good nature to endure ethnic ridiculing that others might find offensive.

At 35, Margaritondo already ranks near the top of his field. His achievements involve probing the electronic structure of metals and semiconductor surfaces. This type of research is on the frontier of solid-state physics, the branch of science that brought us the transistor and, hence, the modern computer.

M.L. Cohen, a leading physicist at the University of California —Berkeley, calls Margaritondo "one of the handful of individuals recognized as world-class researchers in photoemission spectroscopy."

Margaritondo examines surfaces. Typically, he might expose a surface to light (actually photons, which are units of electromagnetic energy) and measure the way the photons bounce off. By watching the behavior of molecules or atoms on copper, silicon or a more complex substance, he hopes to unlock properties that might be useful in future technology — in improving communications, for example, or in creating better resistance to corrosion.

Born in Italy and educated in Rome, Margaritondo

Continued

UW bacteriologist Martha Howe hopes her work will contribute to advances in the control of cancer.

faced a choice early in his career if he wanted to advance: Immigrate to Germany or to Wisconsin. He chose America's Midwest and hopes to stay here. He made that choice because the world's best piece of equipment to do his work is about 20 miles from the Madison campus, in Stoughton: the UW's Synchrotron Radiation Center. At the center, intense beams of ultraviolet light assist researchers in their studies.

Margaritondo also likes Madison — frigid temperatures notwithstanding — because it offers a social climate receptive to outsiders. He and his wife, Marina, and their two daughters have fit into the community easily, he says.

Margaritondo will not predict future practical applications of his work.

"This is the first step in a long chain," he says. "In the past in solid-state physics, we have seen technology following fundamental knowledge by 10 to 25 years.

"We have just started seeing the impact of computers on everyday life. We will all be surprised by the products that are available 20 years from now.

"You don't always know what's going to happen next. You are always pushing the limits. You produce interesting discoveries. They will find their way into the technology."

Lie algebra, quarks and gluons

AS mathematician Georgia Benkart tells the story, words like "lie" and "killing" took on special meaning during the Vietnam War. When the words appeared on documents involving the UW's controversial Army Mathematics Research Center, it was thought they might enrage radicals on the Madison campus.

Actually, says Benkart, "killing" was W.H. Killing, a German mathematician, and "lie" was a Norwegian named Lie (pronounced Lee), the father of a branch of mathematics called lie algebra.

Although the story is told as an anecdote about the protest era, the struggle continues in the minds of some mathematicians, including Benkart, over possible links between pure thought and mass destruction.

At the height of the Vietnam furor, the math center was bombed by war protesters; a UW researcher died in the Aug. 24, 1970, blast.

Benkart says she has no defense contracts and does not work at the Math Research Center. She has not decided whether she would be willing to do work for the Army.

"I supported the nuclear (weapons) freeze," she says, "because it really is craziness being able to kill people 10 times over. I have often wondered what the scientists who worked on the atomic bomb must have felt after they saw what it led to."

Benkart, whose hair tumbles well past her shoulders, is pensive in an interview. Some of her answers come slowly, delivered after lengthy thought.

At 35, Benkart, a native of Youngstown, Ohio, is a world authority on lie algebra. Recently, she and UW colleague Marshall Osborn made a breakthrough on a problem that had stumped the world's best algebraists for the last quarter century.

The breakthrough, she said, would be next to impossible to explain to someone not in mathematics.

"It's a matter of faith," she says of her research. "This is a humbling job in a way. For the most part, people don't understand what you do."

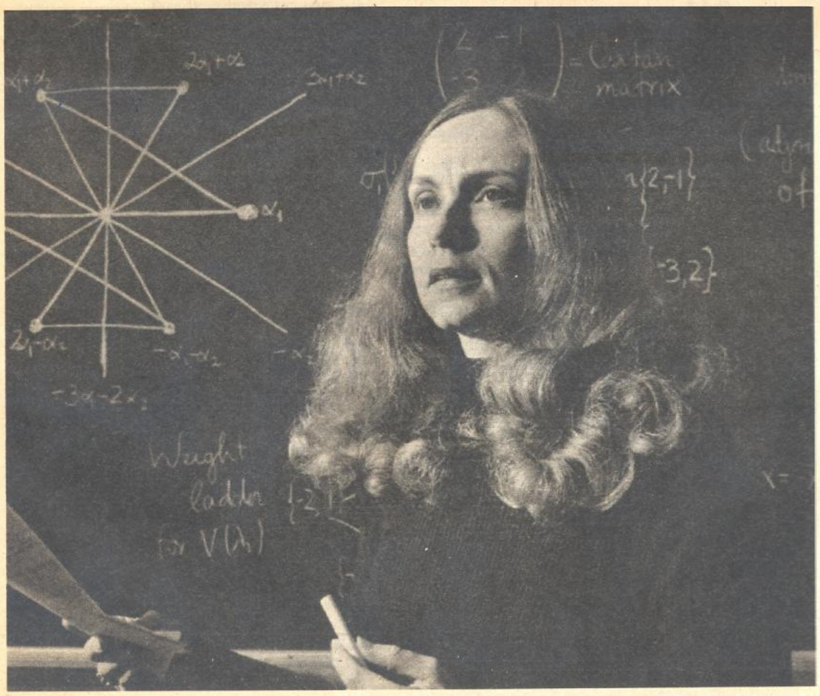
Osborn put it this way: The two of them devised a system of classifying lie algebras in a way that will help physicists to explain the theories of matter better.

Lie algebra underlies small-particle physics. It's the branch of physics responsible for recent discoveries of the minute building blocks of matter: quarks and gluons. Quarks comprise protons and neutrons, which make up atoms, which comprise molecules, which account for all matter. Gluons are elemental particles that bind quarks together.

It is this branch of physics that underlies potential discoveries of new and more efficient forms of energy and that ultimately could have practical applications — applications in the home or, perhaps, on untested battlefields.

"The applications of what I have done may be many, many miles down the road," she says. "We are trying to understand energy sources, trying to understand things about matter and ways that matter can combine." It's research that requires patience.

"When you work for weeks on something and nothing comes of it, you become frustrated. I guess there is some burnout. I would hope to be a good teacher, to do research that is of lasting value."



Ohio-born Georgia Benkart, a UW mathematician, is considered a world authority on lie algebra.

Lasers and fiber optics

JOHN Gilbert has come full circle. A UW — Milwaukee civil engineer, he now does work for the Army, which at one time he did his best to avoid.

Gilbert, once a long-haired lead guitarist for a New York City rock band called "Your Mutha," paid his way through school. The only problem was he got mostly Fs at Brooklyn Polytechnic Institute. It was only when the Army got serious about drafting him that Gilbert hit the books.

This may not sound like an auspicious start for a brilliant young scientist, but Gilbert, who is an associate professor, has become one of UWM's shining stars at the age of 34.

Among those interested in his work is the Army Research Office, which has financed Gilbert's experiments using lasers and fiber optics to analyze the effect of stress on materials. He's able to determine even infinitesimal amounts of stress — as little as one millionth of an inch, for example.

Eventually, Gilbert plans to take the pioneering technology inside the human body for diagnostic purposes. As an example, he might use fiber optics to measure tiny defects within human organs or problems such as cholesterol buildup in arteries.

Fiber optics deals with the transmission of light and images — as around curves — by using a flexible bundle of plastic optical fibers.

Gilbert is not a person one soon forgets. There is a piercing quality to his eyes, and he is refreshingly candid, unafraid to voice — in his New York accent — what might be controversial opinions.

At UWM, he may symbolize the maturing of a relatively new urban university that aspires to greatness. A few years ago, the outspoken young researcher was refused tenure.

"I say what I feel," he admits, "and that sometimes gets me in trouble."

Gilbert also feels he experienced resentment because others in the department did not appreciate or under-

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stand his research. His popularity as a teacher raised eyebrows, too. Maybe he was too popular.

"I keep the class alive," he explains. "I haven't taught the same thing 30 times, which can be a detriment from the standpoint of enthusiasm."

Now, Gilbert maintains that young scientists *are* being nurtured at UWM rather than being discouraged. As a result, he is one of the few researchers anywhere using fiber optics technology for certain materials-testing applications.

He thinks there is room for frontier research at a university with an urban mission.

"I had a hell of a time getting through my department for tenure," he says. Twice he was refused tenure. "Any other person would have quit. [But] the university is maturing. I don't think there would be as much trouble now."

Despite offers to go elsewhere, Gilbert says he is well-placed at UWM. He lives on Milwaukee's West Side, a neighborhood he chose so that his 12-year-old son, Richard, could walk to a racially integrated school. At UWM, he likes to take chances on graduate students who have been underachievers. He identifies with them.

"It is important to me to be free to do the research I'd like to pursue," he says. "If I were in industry, I don't think I'd be as happy."

Unlocking molecular secrets

FLEMING Crim, a lean Texan with traces of a drawl, uses laser beams to probe the dynamics of molecules. His work has wide application in the future use and conservation of energy.

The UW — Madison chemist gets excited when he talks about his research. The words spill out, fast and fluent, and he uses animated gestures to underscore them.

Much of Crim's research is done under the sponsorship of military agencies. As a result, even acquaintances sometimes become critics.

But, explains Crim, friends make the distinction between the individual and the source of his funding. Foes tend to say that without chemists like Crim, modern warfare would be impossible.

"People who disagree with my accepting funding from the military certainly ought to express that opinion," the chemist says. "[But] the science I choose to do is not influenced by those who fund it."

Regardless of his military ties, colleagues regard Crim as a first-rate scientist with international credentials.

He runs two laser-equipped laboratories and has more than $608,000 in current contracts from the Air Force, Army, Navy, the US Department of Energy and the American Chemical Society.

When not on campus, Crim often lectures at other universities. He has conducted seminars for fellow scientists at such weapons labs as Los Alamos (N.M.) National Laboratory and the Air Force Weapons Laboratory at Kirtland Air Force Base, Albuquerque.

At the relatively young age of 35, Crim has won notice from physical chemists. He got his doctorate at Cornell University in New York, then worked for Western Electric Co. and, after that, as a scientist for Los Alamos Laboratory.

In 1977, he had an opportunity to do applied research at Los Alamos, one of the government's main weapons and solar-energy research laboratories. But "an intense desire to do basic research" brought him to the UW because of the university's reputation and its ability to provide what he calls an intellectually satisfying package.

Crim's research typically might examine the decay of a single molecule by energizing it with a short blast of laser light. His experiments involve minute quantities of both materials and time. A common experiment might take two millionths of a second — the time it takes a molecule, when energized by laser light, to break apart.

"The chemistry of reactions is known," he says. "It has been known for a century. We are trying to take simple reactions apart and to understand a single reaction in as much detail as possible."

His research, he explains, is so basic it might lead to advances in anything from better bombs to more energy-efficient engines.

The heavy demands of his job take a toll on family life. Crim negotiated a detailed schedule with his wife, Joyce, that holds him to 60 hours of work a week and also reserves time for Tracy, his 5-year-old daughter.

"For my wife, this career which I enjoy so much has been a big burden," he admits.

Although Crim's research might aid weapons development, he notes that the work is relevant to conventional weapons, not nuclear arms. Moreover, he says, his science is basic to chemistry and has general implications.

"The fundamental things we are studying may have important consequences when someone tries to design some new chemistry down the road," he said. "The real payoff comes not from the things you can look a short distance and see. It really comes from a great distance."

Bacteria and disease

FOR twice the salary and half the freedom, young scientists of his specialty could become "clone jockeys," Rodney Welch says.

He's talking about business firms trying to cash in on gene-splicing technology. Cloning is a way of making "copies" of a gene for research and other purposes. The cloning is done with splicing techniques. This new technology already is being used in some Wisconsin industries.

But conducting science for profit wasn't for the youthful-looking Welch. Instead, shortly after marrying another scientist last August, he opted for the academic life, turning down an attractive job offer from a private firm.

He chose the UW, he says, so he can teach, benefit from interaction with the school's other scientists and choose his own research topics. The 70-hour weeks don't bother him.

Welch plans to use modern genetic engineering techniques to explore an old medical question that has never been answered satisfactorily: How do pathogenic bacteria cause disease? What is the precise genetic mechanism?

Answering such questions, Welch says, will help recognize ways to prevent and cure infectious diseases, such as intestinal and urinary-tract infections and post-surgical infections that are sometimes fatal even when the surgery succeeds.

At present, Welch is especially interested in a substance called homalysin, a protein secreted by *E. coli* bacteria, some of the most common bacteria in human intestinal tracts. Homalysin can destroy phagocytes — cells that help people fight infection. Although antibiotics traditionally have worked as cures, Welch is concerned with how bacteria have become resistant to antibiotics.

He also wants to discover new chemical therapies to combat "opportunistic pathogens," those microorganisms not normally disease-causing that have acquired new genes to make them pathogenic.

While Welch is comfortable with the direction of his own research, he thinks that more research should be done in other areas of science and other areas of the world.

"I am focused upon disease problems of western society," he says. "While others work on problems of less well-developed societies, my work is directed at modern society. For the housewife who is having a recurrent urinary infection, what I am doing is important.

"But there are a number of parasitic diseases in the Third World that are only beginning to be funded for research. Government should be funding more research in this area."

It is more than curiosity about bacteria that drives Welch to work long hours while his wife, Rene, does research in a UW cancer lab elsewhere on the Madison campus. He knows a lot is expected of him.

Welch, 31, joined the UW's Medical Microbiology Department last summer and is now setting up his own laboratory. Senior scientists at the UW think he has potential because of his strong academic background plus experience as a postdoctoral fellow in the laboratory of Stanley Falkow of Stanford University, one of world's leading authorities on bacterial pathogenesis.

Welch has yet to prove himself as a world-class researcher in his own right, and he knows that. But his promise has attracted attention.

"This is an opportunity," he says, "to grow professionally in one of the best departments in the country."

"This is an opportunity," he says, "to grow professionally in one of the best departments in the country."

Multiple uses of energy

ONE of Manfred Morari's colleagues says the 31-year-old Morari is the world's foremost authority on what he does. Maybe that explains why, at the time of his *Insight* interview, Morari was considering employment offers from the Universities of Michigan, Washington and Houston.

Morari's science is chemical engineering, and he has had an international impact for his design of energy-efficient chemical-processing plants.

His integrated process design — based on multiple uses of the same energy in industrial plants — shows promise of helping improve the competitive position of US industrial plants and, hence, of the American economy.

Considering that Wisconsin hopes to capitalize economically on the UW's technological know-how, the overtures to Morari are revealing. Among states worse off economically than Wisconsin, one certainly is Michigan.

The University of Michigan has offered Morari more than a 20% raise and additional benefits. Morari says the state has made 20 tenured engineering openings available at the University of Michigan, where the chemical engineering department alone has a $1 million self-improvement grant.

By contrast, in Wisconsin, Gov. Earl has proposed a $1 million faculty quality fund for the entire university system.

But Wisconsin has advantages in the competition to keep Morari. For one thing, it already employs him. For another, the UW boasts one of the top five chemical engineering departments in the country, and scientists like intellectually stimulating colleagues.

Because of that, Morari illustrates the fragile nature of a great research university.

A slender, bearded man with a European accent, Morari is looking to the future. He plans to be married later this year and says he is seeking "a more balanced life."

At the UW, 19 people in Morari's department — those primarily responsible for the university ranking second nationally in chemical engineering — will retire within 10 years.

"It's up to that younger generation to continue the great tradition," he says. "It will be difficult to stay in the top 10 years from now when we are going through this very critical phase."

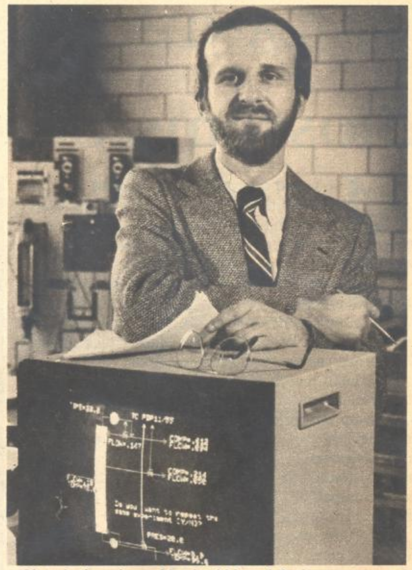
Austrian-born Morari came to the US as a foreign exchange student in high school. He liked it here and later enrolled in the University of Minnesota for graduate studies. After getting his Ph.D., he took the UW job in 1977.

Now, when he is not on campus teaching and developing research, he lectures throughout the world.

When he talks about job offers from other states, Morari says there are two features he likes about other universities: higher salaries and more flexibility.

"In some universities," he says, "I see an attitude on the part of the administation that seems to reflect more of an appreciation for young and productive people. They are responsive to the teaching load. They seem to be more willing to make adjustments."

As for salaries, the UW pays assistant basketball



Chemical engineer Manfred Morari designs energy-efficient chemical-processing plants.

coaches at Madison several thousand dollars more than the average salary of the seven outstanding scientists in this story.

Still, says Morari, the administration has "reacted generously to outside offers I received." But scientists like Morari always may be ripe for raiding by universities elsewhere in the world. The UW may be relying on its reputation and on the hope that scientists place other values higher than salary. As Morari says:

"I could go and hustle the consulting business, but I have no interest in doing so. I did not choose an academic position to make money. Just the fact that I can work on what I like to do is extremely valuable to me."

Pulling in research dollars

NOTED scientists often attract sizable grants for university research. Of the seven young scientists described in the accompanying story, only two — Rodney Welch and Georgia Benkart — receive no outside grants for research. The other five bring in hundreds of thousands of dollars.

Here's a rundown of grants the five currently administer:

- Fleming Crim, chemist: Has $608,851 in outside support. This includes a $20,000 Sloan Fellowship, $29,000 from the American Chemical Society, $100,320 from the Department of Energy, $59,918 from the Army, $125,592 from the Air Force and $274,021 from the Navy. Research contracts call for studies of the decay of molecules.
- Georgio Margaritondo, physicist: Administers a $115,841 contract for the Navy and two contracts for the National Science Foundation totaling $74,700. All the grants involve basic research into the properties of metals and semiconductors.
- Manfred Morari, chemical engineer: Has a $15,000 grant from the Shell Development Co., $307,000 grant from the US Department of Energy and $53,882 from the National Science Foundation. Morari is using the money to design models for energy-efficient industrial plants.
- John Gilbert, civil engineer: Has a $95,680 contract with the Army to use fiber optics to analyze the effect of stress on metals. Also has an $8,807 contract with Allen-Bradley Co. for stress analysis.
- Martha Howe, bacteriologist: Has a $145,638 grant from the National Science Foundation and two grants totaling $143,863 from the National Institutes of Health. She's studying genetic characteristics of the Mu virus.

—J.B.