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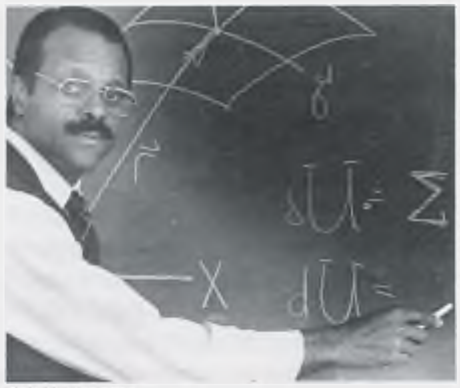
Space Research at Howard: Heralding a New Age

Harriet Jackson Scarupa

The research being undertaken at Howard's Large Space Structures Institute is relevant to building a future space station. The photographs running throughout this article, courtesy of NASA, illustrate how such a space station might look.



PHOTOGRAPHY BY RONALD W. THOMAS

Taft H. Broome

Space Research at Howard

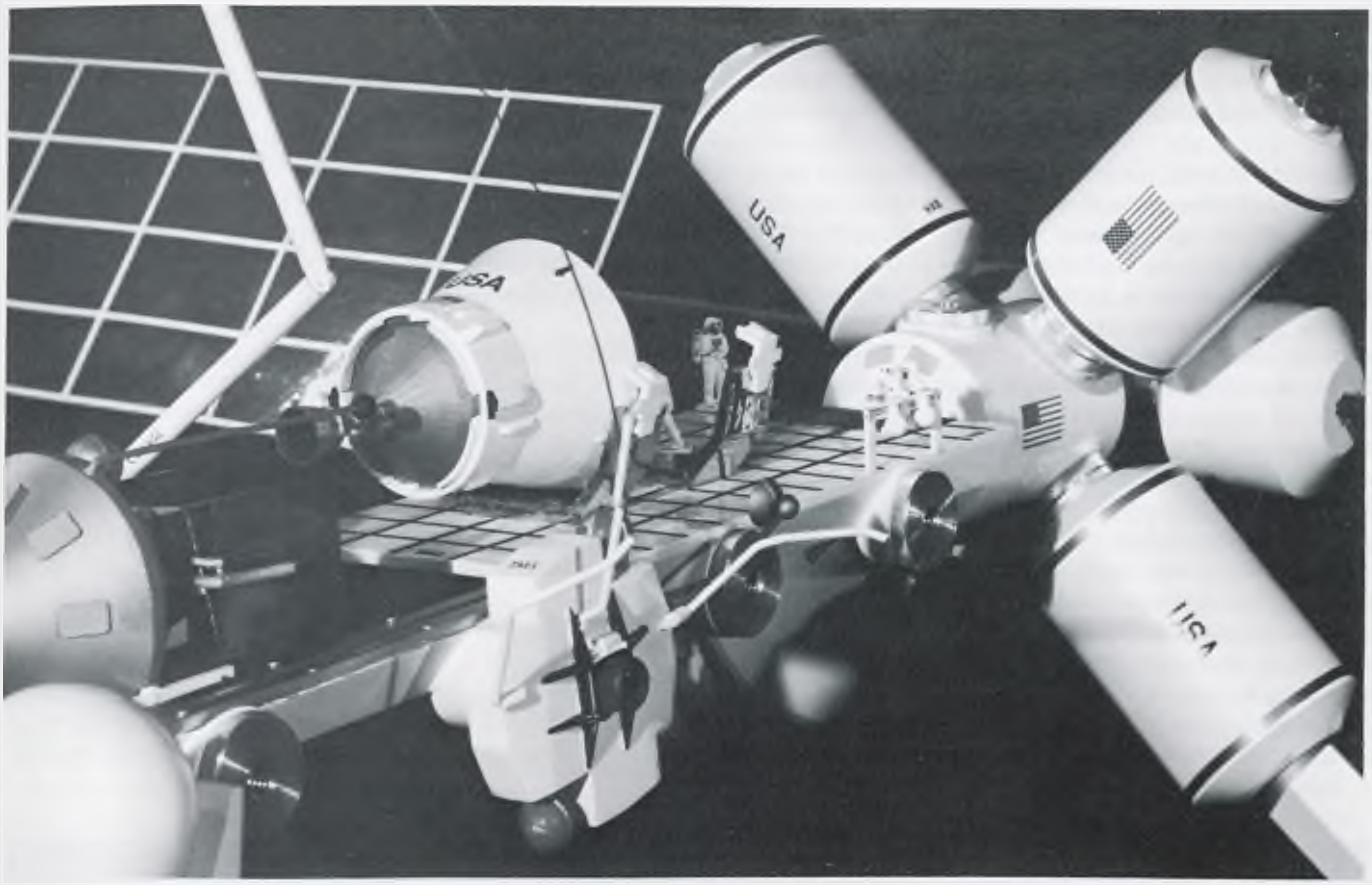
Heralding a New Age

By Harriet Jackson Scarupa

Several American scientists and engineers zoom off on a regularly scheduled space shuttle. Their destination: a space station, i.e. a permanently-manned orbiting structure that had been assembled above the Earth with material transported on earlier shuttle flights.

Upon reaching the comfortably appointed structure, they settle in to conduct a variety of experiments. One, for instance, involves making a promising new drug by combining chemicals that could not be combined on Earth because of the interfering pull of gravity on the ground. From time to time, two of the engineers leave their home base to check on the placement and operation of a large antenna and a large solar-powered satellite which have been set up nearby. Evenings, the scientific-engineering team meets in the space station's conference room to map out plans to construct full-fledged factories in space which would be capable of producing things that would be impossible or extremely difficult to manufacture in the Earth's environment.

Such a scenario could have been penned by a science fiction writer with a particu-



larly vivid imagination. Except that the scenario is getting closer and closer to reality. And the Large Space Structures Institute at Howard University is playing a key role in this progression by developing the theoretical knowledge needed to design and construct large structural systems (spanning a mile or more) to be used in outer space.

The Institute, now in its second year of operation, has been supported by two grants totalling $1,037,500 from the National Aeronautics and Space Administration (NASA) and is one of about a dozen ongoing NASA-supported research projects at Howard. [These projects include studying the effect of weightlessness in space on the cardiovascular system; combining satellite technology and laser chemistry to obtain a detailed understanding of the photochemistry of the parent molecules in comets; and developing fault-tolerant computer software so as to reduce computer errors in space research.] At the beginning of the fall semester, research funds awarded by the agency to the university came to more than $1,250,000 for fiscal year 1984, reports Jurgen Pohly, manager of NASA's Minority University Program.

Also buttressing the work of the Large Space Structures Institute, albeit more indirectly, is a $132,900 grant from the Department of Defense to support a computer graphics center to be used by faculty and students engaged in space-related research at the university.

Pohly points out that one of NASA's objectives in supporting the Institute is to create a body of knowledge contingent to the structural analysis and control of such large space structures as those in our opening scenario: space stations, solar-powered satellites, space antennas and space factories. "This is the research link with NASA's vision and future exploration, the establishment of permanence in space," he says.

More specifically, "the importance of this research is that it will be a critical element in the design of the space station that President [Reagan] just announced last January," explains Dr. Hans Mark, former NASA deputy administrator who is now chancellor of the University of Texas system.

Col. Guion S. Bluford, Jr., the nation's first Black astronaut, reiterates this importance: "NASA is to build a space station in the early 1990s and it's going to be a large structure. So we need to have a good understanding of how you put together such a structure as well as the dynamics of large structures in space. We're also going to be building other large structures in space beyond the space station — large solar panels to pump energy from the sun to the earth, for instance — so there's a strong need for this kind of study."

Another NASA objective in supporting the Howard project is to attract and develop individuals who would be interested in pursuing careers in large space structures engineering. Many students, especially those from minority groups, are reluctant to consider a career in space engineering because they view it as "highly volatile when it comes to spending and the political environment," points out Dr. Taft H. Broome, Jr., an associate professor of engineering at Howard who serves as the Institute's director. "So they opt to go into engineering fields they consider less risky."

"By getting people involved in large space structures research at the student level they have a good opportunity to look into a space career without making financial sacrifices and, by so doing, they can decide for themselves whether or not such a career is worth the investment," Broome adds. "We think that after they've had this exposure a good percentage of them *will* decide to devote their careers to space research."

Broome, himself, seems a particularly appropriate choice to head up a project which aims to attract young people to space engineering. A science fiction enthusiast since childhood, he decided early on that he wanted to do some kind of space-related research. And given the influence of a father whose enduring interest and first academic degree was in architecture, he was naturally drawn to the architectural and engineering side of space exploration.

A recipient of previous NASA grants, Broome believes that the Institute he directs at Howard today represents the agency's response to both scientific and sociological needs. On the scientific side, of course, it aims to produce knowledge that is crucial to future space exploration. Howard was selected for this particular undertaking, observes Mark, because of the "good quality" of NASA-supported research products developed by Howard's faculty members in the past.

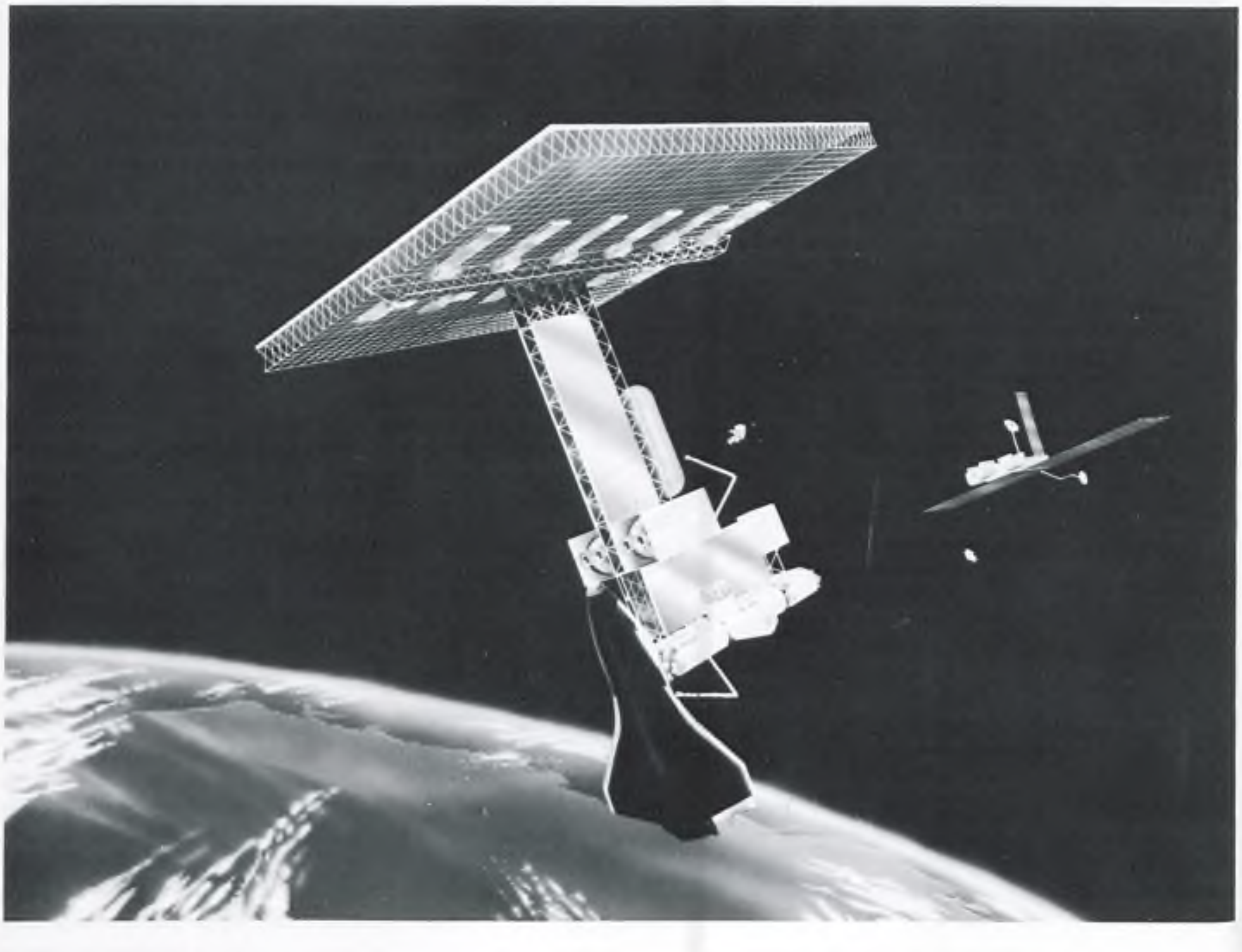
On the sociological side, the Institute serves as a vehicle to increase Black participation in the nation's space program and "it reflects NASA's support of Executive Order 12320 to strengthen historically Black colleges and universities," Pohly observes.

Both sociological and scientific concerns dovetail nicely with those of Howard's School of Engineering. Says the school's dean, Dr. M. Lucius Walker, Jr.: "One of our goals is to provide young men and women education for the future and clearly space is becoming progressively more significant in meeting mankind's needs in the 21st century."

The Research Body

Yet if you ask someone at the School of Engineering where the Large Space Structures Institute is you're likely to be met with a blank stare. That's because the Institute isn't a physical place. It's an organizational structure. It's simply the name for a cooperative effort of individual researchers working on related problems.

Involved in this effort are seven Howard University faculty members: Broome and Dr. Irving W. Jones of the Department of Civil Engineering; Drs. Peter M. Bainum, A. S. S. R. Reddy and Robert Reiss of the Department of Mechanical Engineering; Dr. Ajit K. Choudhury of the Department of Electrical Engineering; and Dr. James Donaldson of the Department of Mathematics. Also involved are two researchers from other American institutions and one from abroad — Dr. Michael Ackroyd of Rensselaer Polytechnic Institute, Dr. James H. Williams, Jr. of the Massachusetts Institute of Technology, and Bo Qian, a visiting scholar from the People's Republic of China. [For a closer look at Chinese scholars at Howard see "The China Connection" in the July 1984 issue of *New Directions*.] Working with the proj-



ect, too, are 17 Howard students — both graduate and undergraduate — about equally divided between those who are American citizens and those who come from India, Iran, Ethiopia, Nigeria and other foreign countries.

The visitor, who might already be confused enough to find that the Large Space Structures Institute really doesn't exist (as a place that is), might likewise be confused or disappointed to observe its investigators in action. With visions of the glamour of space exploration dancing in his head, the visitor would surely expect to find them hard at work building huge science fiction-inspired structures.

Instead, what he'll find are people quietly sitting before computer terminals or at a desk, using paper and pencil or before a blackboard, chalk in hand, as they work out intricate mathematical calculations. And the product of all this effort is not elaborate visionary drawings or models but detailed scholarly papers embellished by enough numbers and mathematical symbols to thoroughly confuse the layman. That this is the case reflects that original key intent of the entire research project: "to develop the *theoretical* knowledge. . . ."

You can think of an engineering project as consisting of various stages," Broome explains. "The last stage is the stage people are familiar with and that's the stage where you build a structure and people see it. A stage that comes before that is a stage where you test your theoretical ideas. And the stage before that is the development of the mathematical models and various ideas about the structure. We're involved in that initial stage.

"We will hand over our papers to the people who will design these structures and they will use our equations to do it. For instance, if they want to know how big a piece of material ought to be to hold a large antenna, they'll use our equations to come up with the answers. That's our role."

He explains further: "We're looking at space structures as a general concept and the kind of work we're doing is applicable generally to any large space structure. We have three main approaches to the problem. Number one is the structural approach which means that we're looking at strength. We're asking: Are these structures strong enough to do the job and what kind of techniques do we use to build them?

"The second approach involves the dynamics and control of the structure. Here we're asking: How does it move and how do you control that movement? If it begins to flop around out there [in space], for instance, how do you stop it? The third approach deals with the optimization of the structure. And here we're asking: How do you maximize the structure's serviceability and minimize its cost?"

Basic Questions

To better understand these three approaches, it helps to know more about large space structures. And to do that some basic questions need to be asked.

Just what exactly are large space structures and by "large" how large do we mean?

"We will hand over our papers to the people who will design these structures and they will use our equations to do it."

Broome answers the question with some concrete examples: "If you saw '2001: Space Odyssey,' the movie showed the space wheel, which could have a diameter of three football fields. That's a large space structure. A solar-powered satellite, which could be two miles by one mile in surface, is a large space structure. What's called a tethered satellite, which is like a long string maybe 60 miles long that hangs from the shuttle down into the upper atmosphere to measure certain atmospheric conditions, is a large space structure. A large antenna, whose diameter could range from that of a football field to a mile across, is a large space structure."

No structure as large as these examples has yet been put in space, he notes. Some satellites now in orbit are slightly larger than a basketball, while a space lab is about the size of a large classroom.

What's the point of putting such a large structure in space? What can such a large structure do?

The answer here, quite simply, is that a large structure can do far more work than a smaller one — whatever that work is. Again, Broome advances some concrete examples: "If you put a large solar-powered satellite in space you can use that to provide electrical power for an entire city and it could provide that power at a much cheaper rate than current methods and not only that, but it would be an alternative to fossil fuels. If you put a large antenna in space you could measure the salinity of the oceans and their temperatures which would allow scientists to monitor the migrations of fish, knowledge that would have obvious practical importance to the fishing industry. Large antennas also could enable scientists to not only monitor weather conditions on Earth more precisely, but also measure the ground water table, information that could help farmers decide when to plant crops."

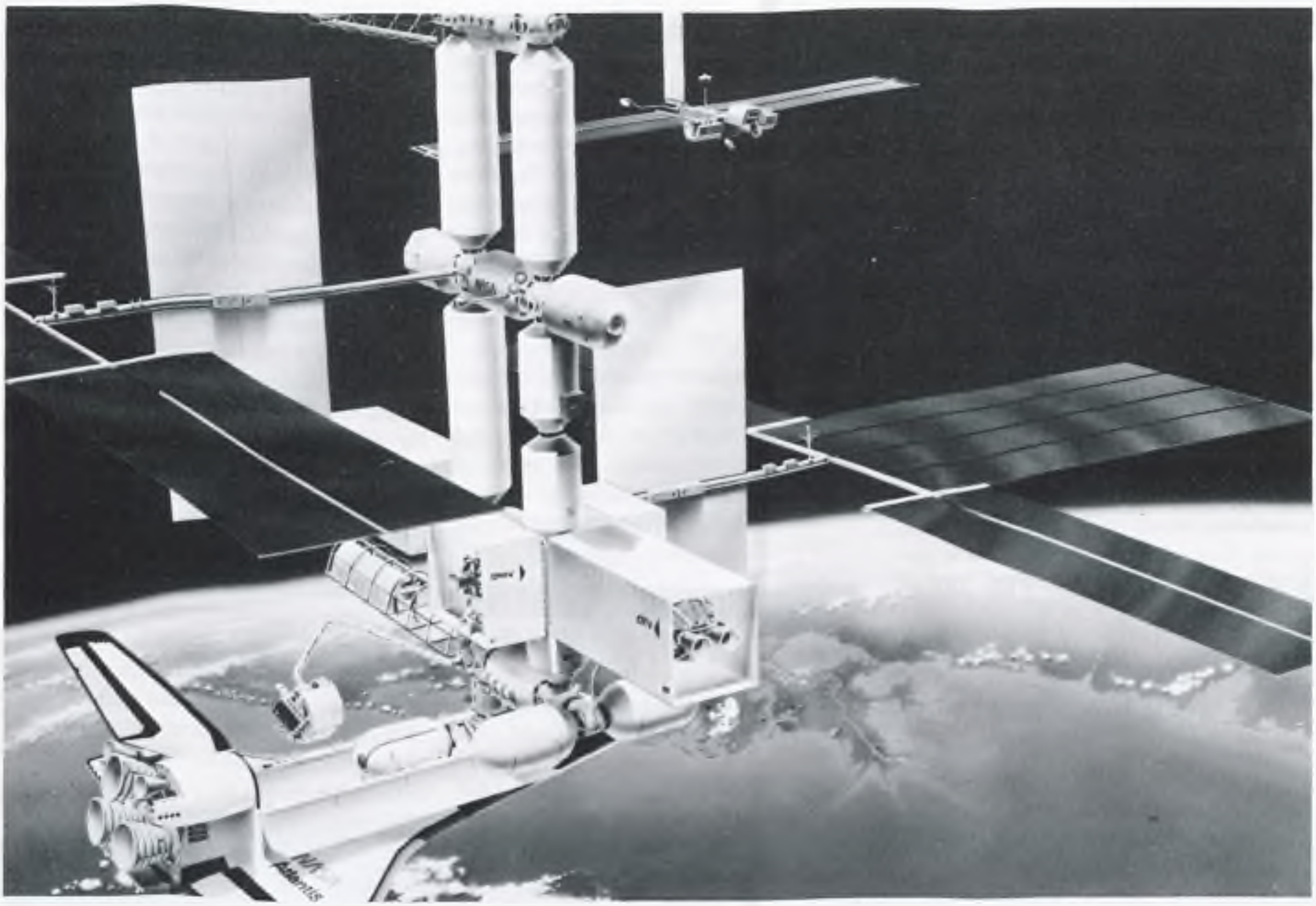
In addition, even to the layman, it seems that large structures in space would have definite military applications, either by serving as platforms for space weapons or antimissle shields or powerful spy satellites, whatever.

"I don't know at this point exactly what the military applications [of the Institute's research] are, but I'm sure there are military applications," says Broome. "You could imagine what could be done with large space platforms and bases," says his colleague Bainum, "but it is not within our charter to consider the [military] use of these things." Bainum and Broome, who both hold distinguished records of research for NASA, seem more comfortable talking about the scientific side of their work. Which leads to another basic question. . .

Why is putting up a large structure in space different from putting up one on Earth?

The answer: it's different because the environment of space is so different as anyone would attest who recalls those television vignettes of astronauts bobbing about like clumsy humanoid balloons. Broom takes note of just a few of the unique properties of space and how they will affect large space structures engineering:

"Because the structure will be in a near zero-g [almost gravity free] environment, you don't have the weight of the structure to hold it in place. So naturally, that presents special challenges. Another characteristic of the environment is the thermal



radiation of the sun. The scientists tell me that a structure that will be partly facing the sun will experience up to 700 degrees Fahrenheit on one side, but on the shaded side the temperature can go down to minus 150 or 200 degrees. So you have to deal with that.

"Also, because of the vast size of these structures we'll have to build them in small parts because the shuttle can only carry parts that are so large. So one of the concepts of building these structures is to build parts of them on Earth and take the parts up in space and assemble the whole structure in space."

As Broome goes on and on, his enthusiasm is palpable, bringing to mind a remark he made earlier about his fascination with science fiction: "To me, science fiction never really departed that much from fact." His remark might well serve as a good transition for taking a closer look at the three approaches to large space structures engineering being pursued at Howard: modeling, dynamics and control, and optimization.

A Team Effort

Broome and his researchers constitute the team working on modeling, i.e. figuring out how to model large space structures that will be strong enough to hold up but not to be so heavy and cumbersome that they could never be transported and erected in space. He has devised a unique approach to calculating the strength of these structures, a form of continuum modeling called the load correction method. "Imagine a huge tinkertoy configuration of a bridge," he explains. "If there are many parts to this configuration and if we stand far enough away from it, then it looks and behaves like a solid, continuous structure." This gives you a graphic feel for this method's approach.

Practically, what the load correction method does is enable the investigator to make a mathematical model of a large space structure without overtaxing the computer by giving it more information than it can handle (or without having to deal with the many, tiny disparate tinkertoy parts that make up the bridge configuration, to continue the graphic analogy.)

Bainum and his researchers are concerned with solving problems related to dynamics and control. "The problem we face is how to test the performance of large space structures which will be erected in zero-g conditions in space under 1g conditions [the type of gravity found on Earth]," he explains. Even if you have a centrifuge or buoyancy tank (machines used for simulating various levels of gravity), you're never going to be able to test in the Earth environment the performance of these very, very large structures. So what we have to do is try to develop mathematical simulations using computer technology mainly, which will predict the way these systems will behave in orbit.

"In our group, we're concerned with how such a large structure moves, how it rotates and how the shape and contour changes. These changes are very important. Let's say you have a multi-beam antenna system with a feed on board and you reflect the electronic signal to a point on the antenna and if the surface is deformed, the beam would be going the wrong way. So the information would never be transmitted back to the desired receiver. These are the kinds of problems we're working on."

Robert Reiss, who heads the optimization team, explains how his team's work fits into the work of the Institute as a whole and the special problems the team faces: "Given the model or certain models Dr. Broome comes up with, we're concerned with how the structure should be designed to maximize its stiffness or minimize its weight. Basically, we're talking about lattice-type structures made of beams and trusses that would be as lightweight as possible. Think of packing material in boxes, for example. If you look at it from the side you'll see lots of holes, yet it still can be very stiff.

"Here, again, the work is very highly mathematical. It involves finding the best answer out of a set of admissible answers. One of the problems we're going to face, I think, is that there's a limit to how much you can improve a design. With given materials today, you can only make a design so stiff and this may not be good enough. Another problem—and it is one of the problems one always faces in optimization work — is coming up with something which is practical in terms of cost while at the same time being close to the mathematical and theoretical optimum. You can have several hundred thousand bars or rods or what have you in a structure. Now the optimum design may require each bar to be different in thickness. Now that's not practical, obviously; the cost would be prohibitive."

The work of the Institute's other investigators either relates directly to the modeling, dynamics and control or optimization of large space structures or is supportive of it. Irving Jones, for example, is working on deployable dynamics, which involves developing mathematical models of structures that can be constructed on Earth, folded up in a shuttle and then opened up in space like an umbrella. A. S. S. R. Reddy is building microprocessors to be used to help solve some of the mathematical problems related to the Institute's work. Ajit Choudhury has worked on particular aspects of control.

James Donaldson serves as a general mathematics resource person for all participants and also is pursuing independent questions related to equations used in the mathematical modeling of large space structures. His participation in the project, he says, reflects his view that "problems arising in engineering, biology and other disciplines energize mathematics" as well as a personal zeal "to work on interesting problems."

At an international conference on ordinary and partial differential equations held in Dundee, Scotland, last summer, Donaldson presented a paper which dealt with an important tool that is applicable to the mathematical modeling of large space structures ("Two-Point Boundary Value Problems in Banach Spaces for Differential Equations with Discontinuous Coefficients"). His paper is just one example of the papers Institute members have presented before scholarly conferences or have had accepted for publication in journals.

Bainum (assisted by graduate student R. Krishna) has been particularly prolific in this regard. He presented a paper on "Control of an Orbiting Flexible Square Platform in the Presence of Solar Radiation" at an international symposium on space technology and science in Tokyo last May, a paper on "Dynamics and Control of Orbiting Flexible Beams and Platforms Under the Influence of Solar Radiation and Thermal Effects" at an astrodynamics conference in Seattle, Wash., in August, and was scheduled to present a paper on "Environmental Effects of the Dynamics and Control of an Orbiting Large Flexible Antenna System" at an international astronautical congress in Lausanne, Switzerland, in October.

Eventually, it is via such papers that the success of the Institute will be measured —at least from the scientific point of view.

But scholarly output isn't the only indicator that will be used to measure the success of the Institute. As Reiss observes, "One of the selling points of this program is to increase the number of minorities in the space field. So our success also will be measured in terms of how well we're able to attract competent Black students into the program."

The Institute involves students in its work through a variety of means. They can be appointed research fellows, which enables them to conduct research under the guidance of Institute faculty and to spend three or ten-week periods at NASA's Langley Research Cen-

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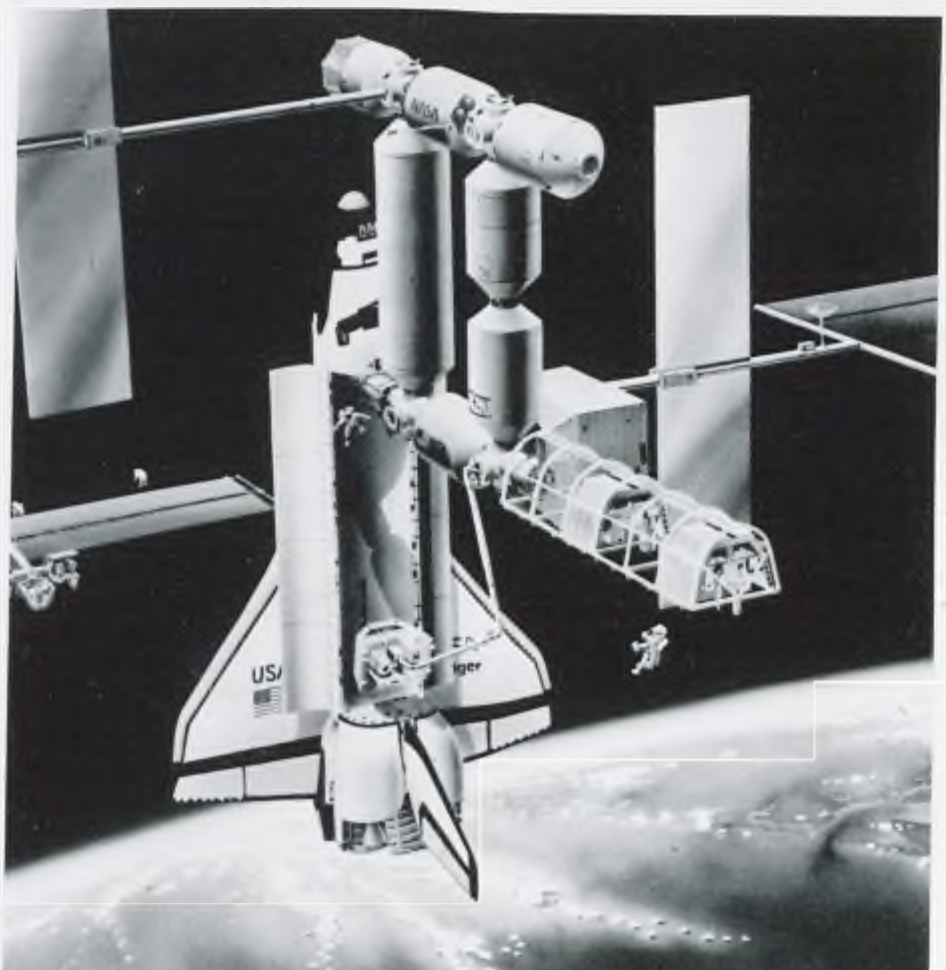

Guion Bluford
Role Model

For many young Black engineers, role models in space-related careers have been virtually non-existent. At least that seemed the case until August 30, 1983, when the Space Shuttle Challenger (STS-8) was launched from Kennedy Space Center, Fla. The shuttle was to complete 98 orbits of the Earth in 145 hours before landing at Edwards Air Force Base, Calif., on September 5, 1983.

On board was a 41-year-old mission specialist with a bachelor's degree in aerospace engineering from Pennsylvania State University, master's and doctoral degrees in aerospace engineering from the Air Force Institute of Technology, an impressive number of hours logged as an Air Force pilot and as an instructor of other pilots, among other accomplishments.

His name was Col. Guion S. Bluford, Jr., and on that voyage he became the first Black American to go into space.

From the Johnson Space Center in Houston, Texas, Bluford responds to questions on a variety of subjects—from the need for increased Black participation in the nation's space program to how it *feels* to be way out there in space. He speaks simply and directly, with an unassuming style that seems to match media portrayals of his personality. Indeed, he even personally returns his phone calls, surely a rarity for most celebrities.

Why do you feel that traditionally there have been so few Blacks involved in space-related work?

That's really pretty hard to say. For some odd reason Blacks have just not been attracted to the science and engineering career fields which are so essential to this kind of work. Maybe it's because we're steered off from them in junior high school and high school. You combine that with the lack of role models out there in the science and engineering fields to encourage Blacks to get into them and the result is that these fields attract very few Blacks.

I think we're all working to try and get more and more minorities in the engineering disciplines. We're making progress but it's still a slow process and it's something that we're all going to have to continually work at until there is some sort of parity in this area.

How about you? How did you personally get interested in space and what were some of the factors that served to encourage you? You obviously never felt that the space program was something that was off limits to you because of your race.

That's right. I was very fortunate. I had a strong role model when I was growing up. My father was a mechanical engineer so that's how I became interested in engineering. As a kid I was always interested in airplanes and rockets and jet engines and I also developed a strong interest in science and math. So I steered towards the engineering field relatively early in life. As a matter of fact, I decided to get into aerospace engineering when I was in junior high school.

But did you ever think that one day you might actually be going out in space yourself, that you would become an astronaut?

Oh, no! As a matter of fact astronauts didn't even exist when I was a kid. My primary interest was in aerospace engineering. I was always fascinated with how airplanes flew and so I sort of ran in that direction. That [aerospace engineering] was my childhood goal and I pursued that as a career and by pursuing that as a career I ended up getting three degrees in that area and then flying and eventually I got into the astronaut program because of my strong interest in the aerospace field itself.

I understand that you're now in training for another space flight. What is it and what will you be doing?

Well, it's a space lab mission in which we'll be flying a laboratory in space. It's being funded by the West German government which, as a matter of fact, has its own NASA. So I'll be a mission specialist-scientist working in the laboratory and we'll be doing materials processing experiments and life sciences experiments on board the shuttle for seven days. It's scheduled right now for October 1985.

Along with another mission specialist [Bonnie Dunbar], I've been spending four to five weeks at a time in Germany talking with scientists and engineers and looking at the hardware and that sort of thing. I'm also learning to speak German so that I can be fluent with the people that I'm working with. It's an exciting challenge for me to not only train for another mission but also to train in a couple of different scientific areas and to learn a foreign language at the same time.

On your first mission you were up in space for six days. What did you think about when you were up there?

You're really pretty busy up there. There's an awful lot of work that needs to be done so you are busy trying to get experiments done or work done [e.g. operating various pieces of equipment] up there in orbit and when you do have time off you spend it looking out the window.

The view out the window is spectacular and it's always worthwhile to sort of float upstairs and sit there and watch the world go by. That's always a fascinating thing. I still remember flying over Florida at night and being able to see the whole peninsula of Florida as well as some of the Caribbean islands. It's just an exciting experience.

Weren't you at all frightened out there in space?

No, not really. It [the Challenger space shuttle] is really an excellent vehicle. It's almost like riding in an airliner in the sense that it's a very comfortable, very dependable vehicle. I was amazed as to how comfortable you get up there. You get so used to working in zero-g [gravity] you begin to think it's a natural thing. I didn't sense any sort of scare or fright or any of that up there.

Very briefly, since a lot of people obviously look at you as a role model, is there any particular advice you have for young people in this regard?

Well, I try to get out and speak with as many audiences as I can, at least with as many student audiences as I can. I try to encourage minorities to stay in school and get as much education as they possibly can and, especially to take as much math and science as possible. That's important no matter what career they go into. It's important that we are qualified to be competitive.

I also try to encourage kids, particularly minority kids, to look at the science and engineering career field areas because I think there are an awful lot of opportunities out there. And I try to use the space program as an example of what one can do when one gets into these career field areas. □

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ter in Hampton, Va., where they further refine their research projects. Fellows, who receive up to $10,000 during the academic year (including tuition) and up to $4,300 over the summer, must be American citizens. Three students have been named fellows since the Institute officially began on July 11, 1983.

Students also serve as research assistants to individual professors, eventually channeling the results of this collaborative research into master's degree theses and projects or doctoral dissertations. Research assistants earn various amounts, depending on experience, educational level and available time, and have numbered 18 to date.

The third component of the student education/recruitment objective of the Institute consists of weekly seminars during the academic year at which Howard and outside investigators discuss some of their latest findings or explore topics of general relevance to space research. The Institute's first seminar in November 1983, for instance, featured Dr. K. C. Park, a senior research scientist at Lockheed Missiles and Space Company's Applied Mechanics Laboratory, speaking on "Computational Issues in Large Space Structures Technology."

Blacks in Engineering

Howard's commitment to developing young Black professionals to work on space research — and in all aspects of engineering, for that matter — seems especially compelling given the still sparse representation of Blacks in engineering. According to a recent National Science Foundation (NSF) report, "Women and Minorities in Science and Engineering," in 1982 only 2.2 percent of nation's employed engineers were Black. And this was so even though the number of Blacks enrolled in engineering training increased by more than 100 percent between 1972 and 1980, as Dr. John B. Slaughter, the former NSF director who is now chancellor at the University of Maryland, noted during a speech at Howard. [See "The World of Science" in the January 1983 issue of *New Directions.*]

Reasons for this dismal underrepresentation are complex and varied but most commentators on the subject cite such factors as poor schooling, particularly in the areas of science and math, low expectations by others (which often are internalized), a dearth of role models and plain old racism.

Observes Broome, whose own undergraduate engineering education was obtained at Howard and who pays tribute to his teachers at the university for giving him "rigor in the fundamentals":

"Many people, principally teachers in high school, honestly feel that Blacks are not capable of abstract thinking and for this reason they don't encourage Blacks to go into fields which involve this type of thinking. I believe this translates into a kind of racism, but I don't think it's a hateful kind of racism. It's not a racism that stems from the standpoint that they don't like Blacks, but from the standpoint that they just don't regard Blacks as smart people as a whole. It's a covert, subtle kind of a thing that's built into the system.

> Why spend so much money on the space effort when there are so many problems still to be solved right here on Earth?

"I do see this [kind of covert racism] as a real problem. But I see that half of the problem is for us as Blacks to get out there and prove ourselves. I don't think that we can expect a person who honestly believes that we're not smart to believe that we are smart unless we prove it. So all we need is the opportunity. And this Institute is exactly that. An opportunity."

The Institute may well serve to prove something else as well, Bainum observes, and that is this: "Space research is not an exclusive club where only majority Americans or Europeans or Japanese can work and lead. Technology is open to all people . . ."

In addition to all this, the Institute's overtures to students represent one response to what some observers are terming a "national crisis in engineering education." The cause of the crisis: more and more American graduates of the nation's engineering schools are opting to go directly into industry (with the lure of very attractive starting salaries and generous benefits) instead of working on advanced degrees. This has left the nation's engineering graduate programs increasingly populated by foreign students, many of whom eventually return to their homelands, taking their expertise with them, while those who choose to stay in the U.S. are viewed as exemplifying the "brain drain" plaguing so many Third World countries. Addressing the crisis in engineering education, an editorial in the July 1984 issue of *Aerospace America* observed:

"For these [undergraduate engineering] students, there is little incentive to go on to graduate school — even to the master's level. The long road to a doctorate — and perhaps a prestigious faculty position — is even less enticing. Visions of junking the "early attic" lifestyle for that of the young, upwardly mobile professional are hard to resist, especially when additional years of academia promise no better reward than can be earned with only a bachelor's degree.

"Given this trend, industry and the engineering education structure may, in fact, be living on borrowed time. With ever more talented young engineers being lured away from school, the numbers prepared to become teachers will continue to dwindle. In a sense, the henhouse is being robbed before the chicks have hatched."

By using lures of its own — the opportunity to engage in especially exciting research, to interact with highly trained and committed professionals and to receive stipends that are far more generous than those typically held by most graduate students — the Institute, in its own way, has set out to entice more American students to pursue graduate studies. The payoff of this for NASA, Bainum says, is that the graduate students who are likely to emerge from the Institute would make ideal recruits for the agency's own research operations.

Graduate Recruits

Consider, for instance, the cases of Stanley Woodard and Cheryl McKissack. Both are research fellows with the Institute. Both were strong undergraduate engineering students. Both are working on master's degrees (Woodard under Bainum's supervision, McKissack under Broome's). Both eventually plan to earn a doctorate which, if present patterns continue, will make them part of a statistically elite group. That NSF report, for instance, noted that of a total of 1,467 engineering doctorates earned in the 1980-81 academic year, only 19 were earned by Blacks. (This compares to 1,092 earned by whites and 282 earned by Asians, tha later figure reflecting the statistical overrepresentation of Asians in engineering and the physical sciences.)

McKissack, who is from Nashville, Tenn., and did her undergraduate work at Howard, says she was attracted to large space structures engineering "because it's kind of a new idea. I thought if I could get into the field now, I'd be there at the very beginning and that would be really good. Also, I'm more interested in the theory behind civil engineering than the design aspect of it. I guess I've always been a scholar type person and maybe have an inventive type mind [she smiles] so maybe that's why the theoretical appeals to me more."

Her thesis involves using the load correction method developed by Broome to analyze large truss structures. [A truss structure consists of rods connected by hinges.] She spent a short residency at NASA's Langley Research Center last summer testing out another continuum modeling method developed by two Langley researchers to analyze these structures. "I don't want to say which method is best," she says, laughing this time. "Every time I do, everybody gets mad. Dr. Broome told me I'm biased [towards his method]. So I guess I'm learning to be more tactful."

Woodard, a Purdue University graduate from Indianapolis, Ind., spent the summer at NASA's Langley Center developing a mathematical model of a space platform that has objects attached to it via tethers. "It's a simple model," he says. "It's a rectangular platform and connected to it you have this cable that maybe has some type of cargo or maybe a person being deployed upward or working on something." "I've been able to pick up a few good tricks on how to develop mathematical models," he says of the Langley experience. "It's also given me the chance to see how NASA works on a day-to-day basis and I've found that very interesting."

Woodard says he is definitely committed to a career in space research. "I went into engineering in the first place for economic reasons — supply and demand; engineers are in demand," he says. "But actually, now I don't look at it that way. I like being here [in engineering, in general, doing space research, in particular] because I like the work that I can do."

It is such an attitude the Institute's faculty hopes to nurture in its student participants. Yet those who set their eyes on working for the nation's space program sometimes have to deal with skepticism and cynicism on the part of others. Lingering behind these feelings are such questions as: Why spend so much money on the space effort when there are so many problems still to be solved right here on Earth? Isn't the whole space effort just a frivolous waste of money? Isn't it simply a glossy way to boost a nation's prestige rather than to meet it real needs?

It's now 26 years since the U.S. launched its first space satellite and 15 years since Neil Armstrong became the first man to step on the moon where he proclaimed those triumphant words: "That's one small step for a man, one giant leap for mankind." Where's all the progress that was supposed to result from these triumphs? How has mankind benefitted?

> "For every dollar that you spend in the NASA program, you generate $8 in residual benefits — employment, new gadgets, improvements in our way of life."

Perhaps the person who can best answer questions along these lines and give a special slant to his answers is that pioneering engineer/astronaut Guion Bluford. [See box, p. 12.]

"I totally disagree with those who consider the space program a waste of money," he says. "There's a statistic out which indicates that for every dollar that you spend in the NASA program, you generate $8 in residual benefits, residual benefits being employment, new gadgets, improvements in our way of life and that sort of thing. I think that's very true and I sense that what we're doing in space right now is going to generate even more jobs in the future — particularly for scientists and engineers — as well as for a lot of other people in the scientific career field areas.

"That's one of the reasons I encourage Blacks to get out there and prepare themselves for careers in science and engineering, because, that is where I think the jobs will be in the future. In the years to come we're going to end up developing a space industry that is going to really revolutionize the way we live. We're beginning to see parts of that now. We've got a $3 billion industry in space communications right now which didn't exist ten years ago and I sense that we will have a billion dollar industry in pharmaceutical manufacturing and crystal growing and related activities. We're going to be very busy in space manufacturing things that are very beneficial for all of us here on Earth."

Then there is another series of questions that are sometimes posed to Black engineers, in particular, when they express an interest in working in the nation's space program. These questions go something like this: Isn't this whole space business just a concern of white folks? Shouldn't we, as Black engineers, be using our skills to deal with some of the massive problems facing our people today, especially for those languishing in deteriorated inner-city communities right here on Earth?

Taft Broome has heard many variations of these questions. As one who has dreamed of a career in space research since boyhood and who now plays a role in that seeming merger of science fiction with "real life," he's come up with an answer with which he feels comfortable.

"I think that some Black engineers need to be involved in problems that are directly related to Black communities," he says. "I think that some Black engineers need to get involved in things that are only indirectly related to any human being. I think that Black engineers, Black people, need to get involved in *everything*. Only by variety can we make important contributions. . . because everyone has different inclinations."

His answer might not satisfy everyone. But he's not all that worried about that. He and the other participants in Howard's Large Space Structures Institute have too much work to do. □