

Keeping Them Up in the Air

by Marilyn Wellemeyer

Merrily he skips through his act, tossing balls above his head, between his legs, and around his body, balancing one on an ear and catching another with his foot. As the audience watches wide-eyed, he keeps seven balls bouncing off the floor, one after the other. All the while, "Mr. B, the Prince of Jugglers" punctuates his antics with funny noises, grimaces, and comic patter. Finishing with a flourish, he lofts three flaming torches into the air.

Few who catch Mr. B's polished performances at hotels, shopping centers, or discos around Chicago suspect that the Prince of Jugglers also practices another exacting profession. As Paul Bachman, midwestern manager of Caleb Brett, U.S.A., he leads a team of experts who verify the quality and quantity of chemical and petroleum shipments by inspecting cargoes as they are loaded and discharged.

Bachman's juggling career began twenty-six years ago at the University of Chicago's now defunct Acro Theatre, where student gymnasts put on spectacular shows. Though he had to give up college for a job, he never stopped tossing balls and perfecting his comic showmanship. Three years ago, a producer from the Chicago Ballet Company saw Bachman's act and picked him for the role of the Mad Hatter in *Alice in Wonderland*. He appeared eighteen times in eleven days at Chicago's 4,300-seat Arie Crown theater—tossing top hats before a bewildered Alice. He had to take a vacation to do it; his job kept him from going on tour with the show.

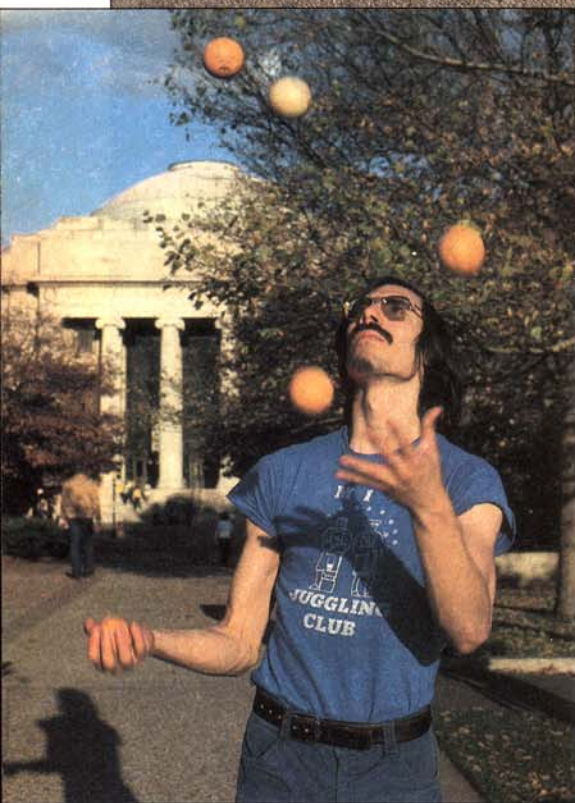
Egyptian ladies liked it

To juggle is, really, to jest, from the Latin, *joculari*, and the movements embody a beautifully structured kind of pure play. All sorts of entertainers have tried their hand at it—from the women of ancient Egypt, who were depicted on a tomb as early as 1900 B.C., to W. C. Fields, who enhanced his 1930's slapstick roles by toss-



Living up a Saturday afternoon, Paul Bachman wows the kids with his comic juggling act at Old Chicago, an indoor amusement park in Bolingbrook, Illinois. Though much in demand as an entertainer, he limits himself to two engagements a week to leave time for his job as the Midwest manager of Caleb Brett,

U.S.A., a British-owned firm that inspects oil and chemical cargoes. His routine is in the best tradition of the old vaudeville jugglers. Bachman perfects his style by watching movies of the great performers; his personal collection of films and photographs covers some 450 jugglers dating back to 1901.



On the M.I.T. campus, Arthur Lewbel, a telecommunications consultant at Data Resources Inc., shows off the five-ball cascade (left). In the photo above, he leads some fellow jugglers in a "five-one feed." All of the jugglers are using three clubs, and Lewbel exchanges a club with each, one after another.

mathematical activity," he says, "with patterns, structure, and organization. In juggling, you have to plan a procedure, like a computer program. It is a physical realization of the same thing."

Beanbags are advised

A few basic patterns provide the foundation for most tricks. To juggle an odd number of objects, a "cascade" pattern is used, with objects tossed alternately from one hand to the other. The three-ball cascade, the simplest of all juggling patterns, starts with two balls in one hand and one in the other. To juggle an even number of objects requires a "fountain" pattern. Instead of alternating from one hand to the other, the objects are tossed and caught with the same hand, so that they spurt straight up and down.

Beginners are advised to use beanbags, which won't roll all over the place, and to face a wall so that the bags are easy to spot. The repeated arm movements must attain a rhythmic consistency for the timing to be right. Once the brain and muscles are trained, the movements become almost automatic and, like bike riding, are never forgotten. Howard Austin, who works for Schlumberger in the special field of computer science known as artificial intelligence, used juggling to illustrate the operation of the mind and muscles in his M.I.T. doctoral thesis, "A Computational Theory of Physical Skill."

Several mathematicians have even talked about building a juggling machine. Claude Shannon, Donner professor emeritus of science at M.I.T. and a director of Teledyne, has probably given it the most thought. Shannon has made several contributions to the development of the computer going back to his *Mathematical Theory of Communication*, published in 1948. But the computer that juggles has not yet been built. "It's easy enough for machines to throw things," says Shannon. "The hard part is getting a computer to catch them." Shannon, who at sixty-three still juggles from time to time, used to surprise his colleagues by riding a unicycle down the halls when he worked at Bell

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ed the discrete-mathematics department there since 1968, has written about the application of combinatorial mathematics to scheduling problems—how to get work done most efficiently. His contraption has nothing to do with that pursuit, however; it comes into play only when he takes time out. He lowers a fifteen-foot-square net from the ceiling to waist level and starts juggling over it. The net keeps balls from crashing to the floor and rolling into inaccessible corners of the room.

Graham's juggling history dates back to the early 1950's and the University of Chicago, where he also developed an addiction to the trampoline and appeared professionally with a group called the Bouncing Baers. "That's just juggling yourself," he says. For the fall quarter he has been teaching computer sciences at Stanford University, and holding extracurricular classes in juggling every Tuesday. Graham doesn't consider it surprising that mathematicians and computer scientists are especially attracted to the sport. "It's a

ing plates and balancing cigar boxes.

Nowadays jugglers are popping up in some of the oddest places: in the streets, in offices, on campuses—M.I.T. and Harvard have become veritable hotbeds of the sport. Some of the finest scientific minds in industry are fascinated by juggling. Unbeknownst to outsiders, a few of the country's most prestigious research institutions have been harboring jugglers for years.

A visitor to Ronald L. Graham's office at Bell Laboratories in Murray Hill, New Jersey, will see a strange contraption dangling from the ceiling. Graham, who has head-

Labs. The computer hasn't been known to master that art, either.

Graham's personal ambition is to juggle seven balls for 100 throws—he can manage six now. As the number of objects increases, juggling becomes vastly more difficult. The juggler has to move much faster and more precisely to win the race against gravity. "If you throw a ball twice as high, that doesn't give you twice as much time, but only 40 percent more," Graham points out. "The speed gets magnified as the ball comes down."

Graduating to five balls separates the casual juggler from the expert. Among performers the acknowledged champion is Sergei Ignatov of the Moscow Circus, who can handle five clubs, seven balls, and eleven rings. Ignatov does it all in long sequences of varied and extremely difficult patterns, such as tossing five clubs behind his back. Graham regrets that the astronauts missed a great opportunity to set an eleven-ball record on the moon. He has tried juggling underwater, only to be confounded by the eddies created by his arm movements.

Because they are still a rare breed in the population as a whole, jugglers seek out

Stuart Reynolds, a research fellow at Du Pont, first began making clubs for himself out of fiberglass and epoxy resin. Word of mouth among professional jugglers soon brought him more business than he could handle.



the company of their peers. Only a juggler can truly appreciate another's skill. On Sunday afternoons, a lot of them gather from near and far at the M.I.T. student center. A sizable contingent hails from Bolt Beranek & Newman Inc., the Cambridge-based firm that helped to analyze the 18.5-minute gap in the Nixon tape and the fourth-bullet theory of the Kennedy assassination. David Walden, a vice president of the firm's computer-systems division, and Eric Roberts, a scientist, got their colleagues interested in the sport. Walden taught himself to juggle over the bed, much to his wife's dismay. Since then, juggling has become so automatic for Walden that he can practice his tricks while listening to Peter Drucker's taped lectures on management.

It takes harmony

A big event at the Sunday sessions is club passing—juggling in formations of two to six people. Each person starts with three clubs, and tosses them back and forth in perfect harmony and a variety of patterns. Somehow, the young scientists seem to get a bigger kick from the teamwork of club-passing than from doing solo tricks.

The climax of the juggler's year comes at the annual convention of the 850-member International Jugglers Association. This year the conclave was organized by two scientists from Bolt Beranek & Newman. Four hundred people converged on the vast gymnasium of Hampshire College in Amherst, where they filled the air with juggling props around the clock.

Stuart Reynolds, a research fellow at Du Pont, has attended almost half of these conventions, starting with the first one in 1948. He was only seventeen at the time, and marveled to see the two or three people in the country who could then juggle five clubs. Since the association introduced formal competitions ten years ago, general proficiency has improved dramatically, particularly among the youngsters. During a three-minute act, contestants are judged on their showmanship and the difficulty of their tricks. In this year's five-club competition, Reynolds placed fourth. The winner

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Noted mathematician Claude Shannon, a director of Teledyne, has a go with the rings.

was a high-school student whom he had tutored.

Juggling has been a big asset in Raynolds's professional life. As a performer, he worked his way through Cornell, and then through a doctorate in chemistry at the University of Pittsburgh. But more important, he says, is the mental outlook with which the sport has equipped him. "Juggling teaches optimism. A beginner thinks that juggling clubs is impossible, and five are beyond belief. But then a juggler realizes that this is a self-imposed limitation. The same is true in research."

At Du Pont, Raynolds has been responsible for the discovery and development of Zepel, a chemical that waterproofs textiles, and Zelcon, which makes certain synthetic fibers wettable so they can be washed. "The things we think we can't do are merely thoughts in our minds," says Raynolds. "If we approach things optimistically and with confidence, we can do them. It has worked a bunch of times. Problems solve themselves." **F**