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TRIBUTE TO GREER ELLIS

June 7, 1910 - October 15, 1997

***Greer Ellis** - Inventor of STRESSCOAT and TENSLAC and of the BAM- and BA-series of signal conditioners.*

This History article is based on a write-up for Greer Ellis' 80th birthday in 1990 by Peter Stein.

Pete Stein and Greer Ellis at the 50-year Jubilee of Strain Gages, Load Cells & Brittle Coatings, 6th International SEM Congress, June 1988. The Jubilee was arranged by the Western Regional Strain Gage Committee.

Greer was born June 7, 1910. He graduated from George Washington University in Washington, D.C., with a B.S. in Physics in 1934. While working at the National Bureau of Standards, he studied for his degree at night. Greer came to Massachusetts Institute of Technology (MIT) in 1936, got into Dr. Stark Draper's classes and started working for him at 50¢ an hour "which wasn't bad for the time," he commented at the June 1, 1989 Mini-Jubilee of his invention, in Cambridge, Massachusetts. "When it came time for my Master's Thesis, my advisor, Prof. Eddie Taylor, suggested I see Prof. A. V. de Forest for an interesting topic on developing a brittle coating which would permit non-destructive stress analysis of parts. The coating on the part should crack at strains

below the yield point of the part, so that strain distributions for directions and magnitude could be studied," he continued. A brittle coating developed in Germany in 1932 had been used to solve crankshaft failure problems on the Zeppelin engine, but the publication did not reveal the nature of the coating. Hamilton Standard offered a $100 prize, a large sum in those days, for the development of such a coating. Greer found that carbon disulfide was the only satisfactory solvent for a rosin-based coating. He had tried all solvents from A through Z. Although it was evil smelling, inflammable, violently explosive and toxic, he used it to formulate a successful brittle coating. "I called it Stresscoat right off the bat. Straincoat sounded too much like Raincoat. I put some in tin cans around Christmas of 1937."

A.V. de Forest was the founder of Magnaflux Corporation. Magnaflux commercialized Stresscoat, which spread around the world rapidly and successfully, but not without trials and tribulations. Frank Tatnall, legendary salesman of testing machines and mechanical strain gages for Baldwin Southwark (now BLH Electronics), distributed cans free of charge during his trips. That, however, did not occur until Spring 1938, and the temperatures and humidity then were quite different from those for which the product had been formulated in the previous Winter. None of it worked and the users condemned Stresscoat, which got off to a very bad start. Not until the evaluations of the effects of temperature and humidity were completed, did the situation change. Positive acceptance followed swiftly. Just before World War II, Greer took a trip to Germany and was amazed to find that the brittle coating method, which had actually been developed in Germany to solve failure problems on the Zeppelin engines, was not in use to any extent. He was left with the general impression that the Germans did not have much use for experimental techniques and preferred analytical ones.

The bonded resistance strain gage was developed that same year, also at MIT and A.V. de Forest was also instrumental in its commercialization, through the Baldwin Southwark Company, now BLH Electronics, who were manufacturing another invention of his, the de Forest Scratch Gage. It is difficult to overestimate the importance which Stresscoat played in the history of experimental mechanics. With it, researchers were able to determine the locations and directions of the highest strains in a structure or a part, which then identified the locations and directions for mounting electric resistance strain gages for detailed and dynamic studies. Sometimes the brittle coating pattern itself was enough too solve important failure problems. William T. "Bill" Bean was one of the early practitioners of the Stresscoat and strain gage fields and established a legendary reputation for his ability to solve experimental mechanics problems. During World War II, Stresscoat made a significant contribution to the solution of failure problems in armament-related hardware, which gave the allies a decided edge over the axis power, which did not have this method available.

Wanting his own business, Greer went back East after some time with Magnaflux, and established his own consulting business as Ellis Associates, becoming a much sought-after consultant with the new tools of the stress analysis field: bonded electric resistance strain gages and Stresscoat brittle coating.

He and his secretary, Ruth Williams, were married March 1, 1941 in Washington, Connecticut. He became a consultant for solving failure problems for industry. His ingenuity with both of these new experimental stress analysis tools led to spectacular solutions of difficult failure problems. He also developed a stress probing technique with which he bonded resistance strain gages to structures with a thermoplastic DeKhotinsky adhesive so that he could soften the adhesive with a heat gun and move the gage to another location for quick strain surveys. He said of that method, “I was solving the problem while others were still discussing what the problem was.” After some time as a consultant his clients kept asking him to sell them the “boxes” he had made for his own consulting practice, so he settled on designing and building signal conditioning and instrumentation for strain gages.

He started with vacuum-tube-based AC-amplifiers with built-in choppers which chopped a zero-bridge-output-voltage into the data, permitting static, as well as dynamic, measurements to be made by both null-balanced and unbalanced measurement. These unusual instruments, now antique, are still the best-designed signal conditioning for their purpose. I am proud, indeed, to own one of every model in my own instrument museum. After a lengthy and cumbersome mathematical analysis of how he designed his balancing circuits I came to the conclusion that they were close to perfection. They were the opposite of all the other commercial designs but their loading factors on the bridge and their linearity were just about perfect. I asked him one day how he had managed to achieve this degree of perfection, knowing he was not partial to mathematical analysis. He replied, “Oh Pete! I just tinkered around until I got what I wanted!”

When transistors came on the scene, Greer designed and built the first DC amplifier in the world, stable enough for strain gage work. “The hot-shot fellow at the time, on transistors, was at Raytheon. I asked him how to make a DC amplifier with less than 1mv drift over night. He replied, “Forget it Bub!” because of their temperature sensitivity. So I bought two of their transistors, put them in a balanced circuit, put my hat over them (as a thermal shield), and went to sleep. The next morning they were within 1mv of each other! I put them in a little thermos bottle to solve the temperature-sensitivity problem. We put a switch in the bridge circuit so you could turn bridge supply off, and then you could re-zero the amplifier and all the thermocouple action at any time during a test, whenever you suspected that zero-drift might have occurred. Then you could turn the bridge power back on and make measurements. Because the other components were stable, you could come back six months later and continue the test! Those two things made a big difference.”

That was the BAM-1 (Bridge Amplifier and Meter), which I still use on all my demos. It was in production until about 1993 at Measurements Group, Inc., Raleigh, NC, who bought Ellis Associates in the 1970s. A remarkable tribute to a superior design, vintage 1955! An almost 40-year production run.

Greer is also the inventor of the other room-temperature brittle coating, which was commercially manufactured by Measurements Group, Inc., Tenslac, which Greer

formulated at their request in the 1970s, in such a way as not to infringe on his own Stresscoat patent. Stresscoat is now owned by Stresscoat Inc., of Upland, CA. Tenslac is no longer commercially available.

For many years, Greer was a popular and exciting lecturer, first with Frank Tatnall's SR-4 Seminars in the late 1940s and early 1950s, then with Bill Murray's Strain Gage Techniques Summer Courses which originated at MIT. Both courses were held all over the United States. Greer also lectured at the 1960 Stress Measurement Symposium at Arizona State University, in Tempe, which I had organized. I first met him during one of the SR-4 Conferences in 1952 and we remained friends to his death.

Greer was a Guest of Honor at the June 1988 celebrations of 50 Years Since the Commercialization of Bonded Strain Gages, Load Cells and Brittle Coatings held in Portland, Oregon at the 6th International Congress of the Society for Experimental Mechanics, coinciding with the 64th Semi-Annual Meeting of the Western Regional Strain Gage Committee. He was awarded an engraved silver dish commemorating his achievements.

"As a teenager, Greer became interested in sailing on the Chesapeake Bay and it became his favorite sport," wrote Ruth. "He sailed monohulls and later, catamarans; also ice-boats on frozen lakes in winter. In 1968 he won the right to represent the United States, sailing the catamaran *Yankee Flyer*, an innovative design employing an experimental wing mast, in the contest for the Little America Cup off the coast of England, but lost to the British team."

"Music was another interest of Greer's. He enjoyed playing alto-saxophone in a local band of amateurs." Son Jim adds, "His saxophone playing is now revived after 50 years, and he plays John Phillip Souza marches with retired members of the Boston Symphony on village greens. He tinkers with the reeds and is always experimenting. He is now into soaring, soloing on gliders since 1987, also after a 50-year hiatus."

Greer's and Ruth's children are Jim, in the Instrument Division of Measurements Group, Raleigh, NC, who is also into offroad motor-biking and biking on his 85-acre farm, where he organizes events. He has a bike business on the side and has been an enthusiast and writer for Observed Trails for over 30 years. David is a Medical Doctor in Millersburg, Pennsylvania, married to Susan, with daughter Katie. Tom, of Boulder, Colorado, owns a business repairing Saab cars and antique sports cars as Green Mountain Motors. He does some racing and enjoys skiing and hiking. Susan is married to Tom Lee and is a substitute teacher in Hawaii with daughter Ali (Alexandra).

Jim wrote a letter in 1990 from which I excerpt, "Another early interest, sailing, later took advantage of his MIT aeronautical engineering studies. His boating career migrated from the Chesapeake in the 1930s to Casco Bay, Maine, in the 1950s and 1960s. A variety of monohulls led to racing 210s (a 30-ft.day-sailer craved by his children) and 505s (a 17' planing boat)."

“Ever the tinkerer, he had half a dozen parameters to fine tune, often in a wet and hectic fashion, when we purchased the 25-ft. catamaran, Thunder, a British Class C racing machine. His three sons enjoyed challenging power boats in a stiff breeze and eventually succeeded in pulling a water skier! Mom, by the way, steadfastly refused to sail with us.”

“The Ellis clan was also involved in ice-boating. Sound aeronautical design became increasingly important as the boats could sail up to four times the wind speed, sometimes reaching 60 mph. By keeping Ellis Associates small, the head man could often spend several hours a day in mid-winter down in the corporate basement sharpening runners or working on the cross planks or fuselage of the Rumpus a low-rig skeeter built around 1942 by the Meade Glider Co. These experiments were then field tested in frigid, high-speed runs and races, and in light airs he was often able to beat much newer and taller boats.”

“Mom and Dad have been doing some traveling/exploring to such places as Key West and the Corkscrew Swamp Sanctuary in Florida. Recently they spent a month in Hawaii (family reunion) visiting the intriguing jungle/desert/mountain ‘mix’ in Hawaii Volcanoes National Park. Back home, it’s back to gathering sea-weed for the raspberry bed, wading for scallops, and the current adventure: learning to find and rise on thermals in a sailplane (glider). He hasn’t slowed down much!”

Over the years we have kept in touch. I called Greer and Ruth on their anniversary and on his birthday each year. Even in 1997 he still remembers me and we chatted although his short-term memory was absent. Sandy and I and many others will feel his absence keenly.

Hats off and kudos to an inveterate tinker! You made the world better and safer and more enjoyable!