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S.S. MANSON

SESA PRESIDENT 1955 - 1956

S.S. (Stan) Manson was an important part of early SESA/SEM history, par-ticularly between the late 1940s and mid 1970s. During that period he served six years on the SESA Executive Committee, including one year as President. Stan gave the 1964 Murray Lecture, received the 1973 Lazan Award, and was in the first elected group of SESA Fellows in 1976. Stan was the session chairman when I presented my first paper in 1949. Seven years later he was President and I served on the Executive Committee. We interacted often and our relationship has always been very cordial. However, Stan is a very private person, and I know little about his life and activities outside SESA. Thus I did not feel qualified to write an SEM History article about him.

Serendipitously, I learned that Stan was currently writing a book with Gary Halford, who was a colleague of Stan's at NASA. Gary is also a former SESA/SEM member, a former colleague, and longtime friend of mine. We really appreciate Gary's finding time to write the following article about Stan, despite a busy schedule. Even though I have known Stan Manson for more than 55 years, I learned a lot and enjoyed reading Gary's article. I hope you will enjoy it too.

— C.E. Taylor, SEM Historian

SEM HISTORY

Emeritus Professor S.S. Manson

Engineer, Prolific Author, Teacher, Humanitarian
SESA President 1955-56

by G.R. Halford, Senior Technologist, NASA Glenn Research Center

S.S. "Stan" Manson is currently retired and completing a two-volume book on the mechanical durability behavior of materials and structures with particular emphasis on cyclic stress-strain response, fatigue, fracture, creep-rupture, and thermal fatigue that culminates a shining 64-year career as a prolific researcher, innovator, author, mentor, and educator. His myriad contributions to the broad field of mechanical durability have been in the form of workable engineering models. These have been a permanent contribution to the multiplicity of facets of this technologically important field. There was no better place to apply his talents than the National Advisory Committee for Aeronautics (NACA) and its successor, in 1958, the National Aeronautics and Space Administration (NASA).

In the Beginning

At age 7, Stan and his family arrived in the United States as immigrants. Somehow, a clerk wrote on the immigration form that his birthday was the 4th of July in 1919. Perhaps this was an insightfully deliberate choice that would give the young fellow a closer bond with his newly-adopted country. Regardless of intent, the end result was indeed a story of success. The actual date of August 14 was missed by just a little over one month. As a brilliant student with a keen mathematical bent, he entered Cooper-Union Institute of Technology and graduated with highest honors in 1937. His score at the Institute in mathematics competition was the highest in the in the school's history for many, many years. He also earned an M.S. at the University of Michigan in 1942.

NACA/NASA

Stan began his professional career with the Langley Research Center of the NACA in Hampton, Virginia, where he was assigned to the Engine Research Division. His first introduction to experimental stress-strain analysis occurred at this time and he immediately began contrib-uting to the emerging field of wire resistance strain gages.

In late 1941, groundbreaking was taking place for the Lewis Flight Propulsion Laboratory in Cleveland, Ohio. In 1943, he was given the opportunity to transfer to the new facility with its cadre of some of the brightest and most highly-motivated engineers. With World War II in full swing, there were additional motivations for being successful. As an adopted *"Yankee-Doodle Dandy, born on the 4th of July,"* Stan was the man. Contributing to the war effort by using his intellectual skills was the best course of action. Soon, numerous NACA technical reports bearing his authorship were forthcoming. His early report titles included frequent reference to "Strain Gages" and means for "Analyzing Strain-Rosette" data. The war effort directed his strain-rosette applications to measuring the magnitudes of loads at bearing locations of aircraft piston engines. To alleviate the tedium of hand calculations, he designed and built his own electronic strain gage rosette analyzer. This was prior to the development of computers. Soon thereafter, he shifted to the application of strain gages to rotating engine shafts, bearings, gas-turbine buckets, and gas-turbine disks — all of this in the 1945-1948 timeframe when gas turbine engines were in their infancy.

Subsequently, Stan's mathematical bent diverted his research interests into computational stress-strain analyses of high-temperature components of gas-turbine engines. Thermal stresses and strains, thermal shock, thermal fatigue, and time-dependent creep became important terms in his everyday vocabulary. Analyses of these non-linear behaviors made for even more complex mathematical expressions. This, of course, was long before the age of computers for performing tasks of this nature. Having to perform tedious numerical calcu-lations led Stan to investigate short-cut, approximate solutions to these highly-complex problems. This avenue of thought stuck with him for the remainder of his career with NASA.

In trying to come to grips with the prediction of thermal fatigue lifetimes of gas-turbine engine components, he seized upon the realization that thermal fatigue lives were extremely low and measured in the tens or hundreds of cycles. This was in sharp contrast to the millions and billions of cycles of elastically-behaving high-cycle fatigue failures for which a great deal was known. In an attempt to reconcile, and better understand this drastic difference, he began analyzing some isothermal reversed bending data generated by George Sachs. The outcome is now history — the basic equation for plasticity—governed, low-cycle fatigue was put forth to help explain thermal fatigue failures. It became known shortly thereafter as the Manson-Coffin Law in honor of the two individuals that, working in different industries, independently arrived at the same basic equation. Today, that equation forms the basis of virtually all strain-based fatigue models for low-cycle and thermal-cycling fatigue.

To make the Manson-Coffin Law more useful to the engineering design community, it was necessary to generate a sizeable data base from which to develop a better understanding of the nature of low-cycle fatigue. Stan, who by now was the Chief of the Materials and Structures Division at the Lewis Research Center, was instrumental, along with Marvin Hirschberg, in creating the world's most advanced low-cycle fatigue facilities in the early 1960s. They used NASA-designed and built closed-loop, servo-controlled testing equipment before the widespread introduction of this technology by the evolving testing machine industry. Several thousand low-cycle fatigue tests were conducted in that laboratory by the mid-1960s. Out of this effort came what is known as the Method of Universal Slopes equation (1964-65) for estimating, from only tensile test properties, the fatigue curves of metals and alloys over the range of 10 to more than a million cycles to failure. Little did Stan or Marv realize that this equation would be the key to assessing the fatigue resistance of almost every material that, more than a decade later, went into the design and construction of the Main Engines of the United States' Space Shuttles.

During the same timeframe, he also worked extensively on developing accurate Time-Temperature Par-ameters (TTP) for extrapolating shorter-time creep-rupture data into the longer life regime for which data were expensive and often too time-consuming to generate. Numerous innovative TTP models were proposed and utilized over the subsequent 25 years.

In the early 1960s, under the direction of Stan, NASA-Lewis awarded a research Grant to Associate Professor JoDean Morrow of the Theoretical and Applied Mechanics Department at the University of Illinois in Urbana-Champaign. The grant was instru-mental in supporting JoDean's first official Ph.D. student — the author of this brief biography. Because of the extraordinary reputation gained by Manson and the Lewis Research Center of NASA, I decided to join the strong research forces in Cleveland over a year before graduating in 1966. This date corresponded with the publication year of Stan's first book on fatigue, *Thermal Stress and Low-Cycle Fatigue*. The bonds made in 1966 have remained continuously strong over the nearly 40 years of uninterrupted research and development in which Stan was an undisputed leader. Over those years, the field of high-temperature creep-fatigue and thermal fatigue testing and life prediction modeling rose to its heyday of productivity and understanding. Engineering models such as the 10% Rule, a Modified Time- and Cycle- Fraction Rule, then the major breakthrough of Strainrange Partitioning for creep-fatigue and thermal fatigue evaluation came to pass in 1971.

At the same time Stan was constantly pressing to develop new models for dealing with the numerous factors that significantly influenced fatigue resistance — multiaxial models, mean stress models, and cumulative fatigue damage models. During these highly productive years, Stan would spend two weeks of his *vacation* time each year to offer short courses on the campus of the Pennsylvania State University. These were well-attended short courses that attracted engineers from a wide range of industries that were looking for practical solutions to their various structural durability problems. This caused numerous industries to adopt the method-ologies that Stan had so carefully crafted over the years. It was through these courses that engineers from the Rocketdyne Division of North American Rockwell became familiar with the Method of Universal Slopes that proved so crucial to the design of the Space Shuttle Main Engines.

Case Western Reserve University

In 1974 Stan decided to retire from NASA after 32 years and joined the faculty of Case Western Reserve University on the East Side of Cleveland. He would then have an opportunity to teach on a more regular basis and be closer to his home as well. It did not interrupt our close technical relationship. During his 20-year career at CWRU, he was sponsored by Oak Ridge National Laboratories, the Electric Power Research Institute, several local industries, and grants from NASA-Lewis. He was able to support a cadre of prolific graduate students. It was during this period of time that work first began on our two-volume book. The efforts continue to keep us in contact on a weekly basis. At age 85, he still aspires to create new means of analyzing the problems of metal fatigue.

Go West Young Man

In 1994, at age 75, Professor Manson officially "retired" for the second time. In his honor, an ASME-sponsored symposium was held in Chicago where he was feted by many. A special plaque was created in his honor that contained the signatures of many dozens of his co-workers, students, and colleagues. It was a grand occasion to pay homage to a man that has always conveyed his ideas and concepts in a clear, understandable fashion. His studies, writings, and lectures on the fundamental behavior of materials are legendary. He remains a titan in his field and his achieve-ments have been acknowledged worldwide.

Shortly after the second retirement, he moved to the Los Angeles area to be nearer to his children. His highly educated family of five has borne him 11 grandchildren and they are the apple of his eye.

On a personal note, Stan's religious and moral convictions have had a strong influence on his everyday activities and how he deals with each and every person he comes in contact with. After many years of close interaction with him, I never once heard expression of anger — displeasure, perhaps — but never anger. The successes of his children give testimony to his devotion to family. He maintains a pervasively positive attitude and a strong purpose toward life. He has also been a man of great generosity and has helped countless charities over the years. As an example, while still in Cleveland, he became quite active with Habitat for Humanity. He enriches the lives of all he contacts. As one colleague stated so well, "Stan, I'm *always* glad to see you!" I just wish I had been the one to say that.

— Gary R. Halford■