Celebrating 75 Years of the Society for Experimental Mechanics and the Study of Dynamic Behavior of Materials

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This year marks the 75th Anniversary of the Society for Experimental Mechanics (SEM). In 1943 the Society for Experimental Stress Analysis (SESA), the forbearer of SEM was born out of a meeting of the Eastern Photoelastic Conference [1]. While the 1943 meeting was formally the Seventeenth Semi-Annual Eastern Photoelastic Conference and Experimental Stress Symposium, the Conference Executive Committee included numerous luminaries leading the much broader field of Experimental Mechanics including William M. Murray, Thomas J. Dolan, Miklos Hetenyi, Charles Lipson, Raymond D. Mindlin, Elmer K. Timby, F. G. Switzer, and E. O. Waters. Murray, Hetenyi and Lipson proposed that a dues-paying organization be formed with a focus beyond any one particular technique. Along with R. D. Mindlin, they formed the organizing group for the new society and went on to serve as the first four presidents. Lipson worked for the Engineering Institute of the Chrysler Corporation which hosted the conference and funded the Conference Proceedings that became Volume 1 Number 1 of the SESA Proceedings. The society continued to be known as SESA through the 1984 Fall meeting in Milwaukee, WI [2] and took on the current name of the Society for Experimental Mechanics with the 1985 Spring SEM meeting in Las Vegas, NV [3]. Lipton opened that first 1943 meeting with [4]:

Members of the Photoelasticity Conference and Guests
In opening this, the Seventeenth Eastern Photoelasticity Conference and Experimental Stress Symposium, may I first of all welcome to Detroit our out-of-town members and guests. In these times of war, it is particularly fitting that this meeting should be held here in Detroit, the city so closely associated with our industrial war effort. We are also pleased to see so many

Detroit firms represented, for although we frequently consult each other on specific problems this offers a unique opportunity to meet for a more extensive purpose. It is our sincere hope that the technical papers you are about to hear, the exhibit you will see, and the personal contacts you will make will be of benefit to yourselves and to the war effort.

This represents the first time that men interested in all phases of stress analysis are meeting on a common ground to exchange ideas and to derive the benefit of each other's experience. Numerous diversified professional men are represented here, including metallurgists, physicists, chemists, mechanical engineers, designers, etc. It is through forums such as this that the extension of stress analysis will be given further impetus.

Your host at this conference is the Engineering Institute of the Chrysler Corporation. Our organization has long been interested in the subject of stress analysis and in the last few years this activity has received special emphasis from our Engineering Management. It is particularly fitting, therefore, to introduce to you at this time the man whose leadership and interest in stress analysis was largely responsible for the rapid development of this activity in our organization. It gives me great pleasure to present to you the Chief Engineer of Chrysler Corporation, Mr. James C. Zeder. Mr. Zeder.

Even in those early days the collaborative and interdisciplinary approach that underpins the work of many SEM members today was evident. The opening comments were also reflective of the time, with many references to war. When that first conference was held, World War II had gripped the world for nearly 4 years and the United States had entered the war 18 months earlier. While the SEM Dynamic Behavior of Materials Technical Division was not formed until 2006, SEM was formed during the formative era of that field. The year 1943 saw the official commissioning of Los Alamos, at the time known as Project Y, as the

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top-secret location for the development of the first nuclear weapons. Much of the early work in developing the field of shock physics and advancements in modern high explosives, relevant to the field of dynamic behavior of materials, came out of Los Alamos National Laboratory [5]. The Liberty Ship SS John P. Gaines broke in two and sank with the loss of 10 lives in 1943, due to what was later determined to be a material failure. Specifically, the welded construction combined with the grade of steel used had caused embrittlement. A number of other Liberty ships suffered similar problems, serving as one of the classic examples of fracture and motivating the study of fracture and dynamic crack growth. The Colossus computer, the first electronic programmable computer was built in 1943 in the United Kingdom and US-built Electronic Numerical Integrator and Computer (ENIAC) started development in 1943. Computers are now ubiquitous in the research setting. Later in the decade, Herbert Kolsky [6] introduced the use of two Hopkinson bars in series to measure stress and strain, building on early work of Bertram Hopkinson [7]. The resultant Split Hopkinson Pressure Bar or Kolsky Bar has been studied and advanced significantly by the SEM community. In the same period, Geoffrey I Taylor was using flat ended projectiles, later known as the Taylor Rod, for determining dynamic yield stress [8]. More broadly, in 1943 the Humphrey Bogart classic *Casablanca* was in theaters and the first U.S. televised network newscast would not appear until 1944 on NBC. According to a 1945 Gallup poll most Americans did not yet know what television was. Cars did not yet come with seatbelts (even as options), steam locomotives were still common on trains, and jet fighter planes were in development with the first production jet planes—the Messerschmitt Me 262 and then the Gloster Meteor -entering service in 1944. Finally, the transistor would not be invented until 1947.

Those early days of SEM and the post war period that followed included many exciting and seminal works in the field of dynamic behavior of materials, as captured in the SESA Proceedings and later Experimental Mechanics, Experimental Techniques, the SEM Proceedings, and the Journal of Dynamic Behavior of Materials. The first issue of Experimental Mechanics (EM) in 1961 included techniques for full-scale missile structures under simulated re-entry environment by Nichols of Lockheed Missiles and Space Division [9]. Later papers in that volume included a photothermoelastic analysis of bonded propellant grains [10], a review of shock motions and their measurement [11], eccentric longitudinal impact of a beam [12], and photoelastic studies of propagating stress waves [13]. There have been several publications in EM over the past 75 years studying the effect of strain-rate on material response, often bridging multiple loading techniques, such as [14–18]. Building on the society's history in photoelastic coatings and full field methods there have been expansive studies into dynamic

fracture mechanics, such as [19–25]. SEM members have contributed significantly to advances in the Split Hopkinson Pressure Bar (SHPB) or Kolsky Bar technique [6], expanding its loading range, analysis, and material applicability [25–30], methods have been developed for heating specimens [31], and moving from strain gages to embedded quartz force transducers [32, 33]. The SHPB has been expanded into tensile loading [34–37] including 3D full field strain measurements [38], shear loading through both torsion bars [39] and specimen design [40], fracture [41], and dynamic friction measurements [42]. The technique of combined pressure-shear loading with a gas gun was introduced [43] and advanced [44]. Expanding ring methods have been applied to measurement of dynamic constitutive response [45] and fragmentation [46]. A range of impact studies have been reported [47–49]. Techniques for the measurement of spall based on laser [50] and mechanical loading [51] have been presented. More broadly the community has presented on topics ranging from microstructure and mechanical properties in shock-hardened metals [52], to laser-interferometer instrumentation techniques for the study of plane-stress-wave propagation [53], to optimizing material strength constants numerically extracted from Taylor impact data [54], to blast mitigation in a sandwich composite using graded core and polyurea interlayers [55]. The papers referenced here represent only a small fraction of the work published in the field in EM.

Out of this rich history of the study of dynamic behavior of materials within the SEM community, the Journal of Dynamic Behavior of Materials (JDBM) was launched by SEM in 2015 [56]. The journal is highly international, publishing experimental and theoretical studies of metals [57], polymers [58], glasses [59], composites [60], granular materials [61], explosives [62], biological materials [63], geological materials [64], phase transitions [65], and structural response [66]. The journal includes application and development of techniques including split Hopkinson pressure bar/Kolsky bar [67], plate impact with light gas guns and powder guns [68], Taylor Anvil [69], Dynamic-Tensile-Extrusion [70], spectroscopy- and pyrometry-based shock temperature measurements [71], optical and X-ray imaging methods [72], interferometry and velocimetry techniques [73], dynamic fracture [74], laser based dynamic drivers [75], penetration and ballistics [76], equation of state [77], and spall failure [78].

Early in the days of SEM, Rudolph E. Peterson, a Manager of the Mechanics Department at Westinghouse Research Laboratories and a very highly respected member of the international mechanics community, served as the SESA President 1948–1949 [79]. The R. E. Peterson Award is named in his honor, and since 2017 has been the annual SEM best paper award for the Journal of Dynamic Behavior of Materials (JDBM). The R. E. Peterson Award

from the inaugural 2015 volume of JDBM was awarded to Christopher Salisbury, Duane Cronin, and Fue-Sang Lien at the 2017 SEM Conference for their work on Deformation Mechanics of a Non-linear Hyper-viscoelastic Porous Material, Parts I&II [80, 81].

Congratulations to SEM in celebrating our 75th anniversary! More on the History of SEM can be found in Charles “Chuck” E. Taylor’s SEM History Series in Experimental Techniques including the SESA 40th Anniversary [82], the SEM 50th Anniversary [83], and the story of the beginnings of the Friendly Society [84]. We look forward to many more years to come of outstanding technical exchange in the friendly society covering all techniques and areas of experimental mechanics, including dynamic behavior of materials. Thank you to everyone who continues to make of the Journal of Dynamic Behavior of Materials a success including the authors without whom the journal would not be possible, the Associate Technical Editors: Nadia Bahlouli, Nicola Bonora, Neil K. Bourne, Daniel T. Casem, Ellen K. Cerreta, Trevor Cloete, Kathryn A. Dannemann, Jow-Lian Ding, Pascal Forquin, Mikko Hokka, Jennifer L. Jordan, Leslie Lamberson, Jeffrey Nguyen, Thomas D. Sewell, Bo Song, Parameswaran Venkitanarayanan, Tracy Vogler, and Takashi Yokoyama, the Advisory Board members: Arun Shukla (Chair), Dana M. Dattelbaum, William L. Fournery, Yogendra Gupta, K. T. Ramesh, Naresh Thadhani, and Hareesh Tippur, and SEM Staff.

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