HYPERVELOCITY IMPACT SOCIETY

Volume 2, Issue No. 1
August 1995

NEWSLETTER

1994 HYPERVELOCITY IMPACT SYMPOSIUM

A Successful Conference

Approximately 350 people attended the *1994 HVIS* in Santa Fe. Here are a few facts concerning the Symposium. 186 abstracts were submitted for consideration, with 156 of these selected. Since the proceedings are published in the *International Journal of Impact Engineering*, all papers had to be reviewed. Therefore, all authors were required to submit a draft manuscript for peer review prior to acceptance of the paper (both for the Journal and the Symposium). A total of 108 papers were received and reviewed. Some of these papers did not make it through the peer review process (in several cases, the papers were excellent, but the *HVIS* was the wrong forum for the presentation of the material, and the author(s) were encouraged to submit their paper directly to a journal). A large percentage of the authors had to make significant revisions to their manuscripts before final acceptance. This process improved the overall quality of the papers and the conference.

Keynote and Plenary Lectures

Several outstanding speakers were scheduled for the *1994 HVIS*. The invited talks were:

The Crash of Periodic Comet Shoemaker-Levy 9 on Jupiter, by Dr. Eugene Shoemaker, U. S. Geological Survey (Keynote Lecture). Analysis of the spectacular impact of Shoemaker-Levy 9 on Jupiter provided unprecedented information about Jupiter and the planetary consequence of cometary impact. Analysis of this impact seems to have created more questions than answers; the experimental data and modeling efforts will continue for quite some time.

The Use of Shock-Structure Methods for Evaluating High-Pressure Constitutive Properties, by Dr. James Asay, Sandia National Laboratories (Distinguished Scientist Award Lecture). Jim presented a review of his work to investigate and understand phase transitions and strength effects under dynamic loading conditions. Jim's talk was organized as follows:

- Brief review of shock wave profile techniques
- Dynamic yielding/high-pressure strength
- Phase transitions—polymorphic, melting, vaporization
- Future opportunities.

The HVIS community congratulations Jim on receiving the award. Plans are to publish Jim's talk in the proceedings of the *1996 HVIS*.

SHARP—The Jules Verne Launcher, by Dr. John Hunter, Lawrence Livermore National Laboratory (Plenary Lecture). John discussed the world's largest two-stage light-gas gun. Boy, is it ever big...and with a right-angle bend in it, too! The use of light-gas guns to launch payloads and satellites into low-earth orbit may lower the cost by up to a factor of twenty over conventional systems.

Swords-to-Plowshares: Shock Wave Applications for Advanced Photolithography, by Dr. Timothy Trucano, Sandia National Labs. (Plenary Lecture). Experimental and computational methods of shock-wave physics are playing an important role in developing the next generation of photolithographic techniques for integrated circuit applications. Tim showed how shock wave tools, including analysis using the Eulerian wavecode CTH, were successfully being applied to integrated circuit (IC) applications.

Special Session

A special poster session on the Shoemaker-Levy 9 comet impact on Jupiter was scheduled for noon on Monday, October 17 (the day Dr. Shoemaker delivered his Keynote Lecture). This informal session was suggested by Dennis Orphal and organized by Mark Boslough. Fifteen posters were presented at *Comet Day*; the meeting afforded an opportunity to share information, work, and some lively discussion. It was reported in *Nature* (Vol. 372, Dec. 1, 1994) that the *1994 HVIS* was the first post-crash meeting concerning the impact of Shoemaker-Levy!

Student Grants

Grants were provided for students to attend the *1994 HVIS*. Grants included transportation and lodging (up to a limit of $1000 per individual), registration fees, a copy of the proceedings, and a short introductory meeting with the HVIS Board and Committee members. Applicants were recommended by the student's advisor, and selected by the Educational Outreach Committee (Gordon Johnson, Peter Schulz, and Bill Isbell). Nine students were recipients of the grants:

- Lucinda Berthoud, French Ministry of Defense Research Center; CERT-ONERA
- James Cazamias, The University of Texas at Austin
- Matthew LaFontaine, University of Dayton
- Kezhun Li, University of California–Berkeley
- Michael Nolan, University of Arizona
- Brian Peterson, Stanford University
- Ralf Thomas Schmitt, Westfalische Wilhelms Universitat
- Seiji Sugita, Brown University
- Toshiko Takata, California Institute of Technology

It was nice having these young people participate in the Symposium.

WORDS FROM OUR PRESIDENT

Challenges and Opportunities

Probably the biggest challenge to hypervelocity science in the next few years is non-technical. It is to reverse the trend of declining budget for hypervelocity research. I don't need to tell anyone how difficult achieving that objective will be. But it won't happen by accident. So if you have ideas or are willing to help, please let me know.

A challenge facing the Society will be holding our first Symposium outside the U.S. Alois Stilp and Volker Hohler and the excellent staff at the Ernst Mach Institut will do their part and host a not-to-be missed symposium. October in Germany is certainly hard to beat. But for the Symposium to be truly successful we need to maintain or even increase the attendance. In the current budget climate it will be more difficult than usual to travel, so as a minimum we must all plan (scheme?) in advance if we are to maintain and even increase the success of the Symposia. As a reminder, the next Symposium is in Freiberg, Germany, October 7-10, 1996. So far, from the 1986 Symposium in San Antonio though the 1994 Symposium in Santa Fe, we have had an attendance ranging between roughly 300 to 400. Let's beat those numbers in 1996.

Opportunities. There are so many. But we have just recently had what I consider to be two major breakthroughs in hypervelocity launch technologies so let me just mention those as examples. As you all heard in Santa Fe, Lalit Chhabildas and his team at Sandia Laboratories have successfully launched 0.1 to 1 gram, L/D~0.5 Ti and Al alloy projectiles to a velocity of 15.8 km/s. They used a new technique that they call an impact-generated acceleration reservoir. It was only a couple of years ago the highest velocity they had achieved using the graded density technique was about 12 km/s.

Now, I've just learned from the Ballistics Range group at the Arnold Engineering Development Center (AEDC) in Tullahoma, TN, that they have achieved impact velocities of over 12 km/s using the counterfire technique, firing two projectiles at one another, each traveling about 6 km/s. In the experiments just completed they impacted not only "semi-infinite" targets, but also a "spaced bumper" target. And not only did they achieve a 12 km/s impact, *they also soft-recovered the target*!! More information on this achievement will be published in the next Newsletter.

Both of these hypervelocity launch breakthroughs offer opportunities many of us have dreamed of for a long time: the chance to study the shock equation of state and vaporization for the materials we're really interested in; and the opportunity to study the mechanics and performance of Whipple and other types of impact shields at the real velocities of interest. And I'm sure this is just the beginning. The history of all the sciences illustrate that major new understanding always follows a breakthrough in instrumentation or experimental capability. The opportunities are there—and so are the challenges. It should be a lot of fun, and a lot of work, for all of us.

Dennis Orphal
President

WORDS FROM OUR PAST PRESIDENT

Reflective Thoughts on the Past Term

As my term of office comes to an end, I would like to take this opportunity to thank all of those who contributed to the accomplishments made by the Society over the past two years. I am particularly appreciative of the hard work and dedication that went into the *1994 HVIS*.

HVIS 94 was extremely successful in meeting the technical objectives of the Society and exceeded the expectations of the organizing community in several ways, including a record number of submitted abstracts and final manuscripts, a large participation by the international community and a large turnout by the planetary community to discuss a topic of current interest. The diversity of featured technical issues and topics was energizing to the attendees at the Symposium and reflects the breadth of contribution that this field can make to other areas of national and international importance. The large attendance at the Symposium was particularly gratifying, given the decline in defense funding in the recent past.

I am especially pleased with several new activities that were initiated during this term. One of these is the HVIS Newsletter, which provides a forum for keeping members informed of important events in this field and for deliberating issues of importance to the community. Another is the Educational Outreach program that encourages participation of students in HVIS activities which, in my opinion, is essential to the continued vitality and health of this field.

Although we face many challenges in maintaining technical and political interest in this area, I am optimistic that the HVIS Society will continue to provide a valuable service to scientists and engineers in this and related fields and will continue to expand its influence to a broader spectrum of technologies.

Jim Asay
Past President

SOCIETY NEWS

Election for the Board of Directors

Members to the Board of Directors of the Hypervelocity Impact Society are elected by the general membership and serve for three terms (a term is defined as the time between symposia). Charles Anderson, Harry Fair, and Gordon Johnson left the Board at the *1994 HVIS*. The new Board members are Dr. Lalit C. Chhabildas and Ms. Jeanne L. Crews. The Board then elects the officers of the Society—per the Society's *Constitution and By-Laws*—subject to the condition that no officer serves consecutive terms. The officers and Board Members are:

- Dennis L. Orphal, President
- James R. Asay, Past President
- Lalit C. Chhabildas, Secretary-Treasurer
- Dennis E. Grady
- Jeanne L. Crews
- Alois J. Stilp

Andy Piekutowski, Chairman of the Nominations Committee, reported that approximately one-half of the membership returned their ballots. He also provided intriguing statistics on how people returned their ballots, how they filled out their ballots (check marks or x's), and a host of other details. Rather interesting, one ballot had only one vote, and one ballot voted for three of the candidates. For those that read the last newsletter, Andy had already told me that I could only vote for two...so I wasn't the "three-voter."

Welcome to the new Board members, Jeanne and Lalit.

Constitution and Bylaws

If you wish a copy of the *Constitution and Bylaws of the Hypervelocity Impact Society*, please request a copy from Charlie Anderson (phone: 210-522-2313; fax: 210-522-3042; e-mail: canderson@swri.edu). E-mail or fax is preferred; please include your address, and if you are connected to Internet, your e-mail address.

Distinguished Scientist Award Lecture

Alex Charters was awarded the Society's Distinguished Scientist Award in 1989. We have extra copies of Alex Charters' *The Early Years*, and if you wish a copy, please request a copy from Charlie Anderson. As above, e-mail or fax is preferred since I then have a "hard" copy of the request. Alex's talk is also being published in the *1994 HVIS* proceedings.

1994 HVIS Proceedings

The proceedings should be showing up sometime during the early fall. The approximately 975-page volume contains 83 technical articles, an author index, a subject index, and a list of attendees. The volume includes the Distinguished Scientist Keynote presentations from the *1989* and *1992 HVIS* symposia (Alex Charters, and Alois Stilp and Volker Hohler, respectively) along with the introductory tributes by Dennis Orphal (for Alex) and Gustov Schröder (for Alois and Volker).

Extra Copies of the 1994 HVIS Proceedings

Extra copies of the *1994 HVIS* proceedings, Volume 17 of the *International Journal of Impact Engineering*, can be obtained at $100.00 per copy. If you wish one or more additional copies, please submit to:

Dr. Lalit Chhabildas
Sandia National Laboratories
P.O. Box 5800 MS 0821
Albuquerque, NM 87185-5800

Checks should be made out to the Hypervelocity Impact Society, and must be prepaid. Please include your name and address with submittal of the check. Phone (505-844-4147) or fax (505-844-0918) will be accepted provided the check follows.

1996 Hypervelocity Impact Symposium

The next *HVIS* is scheduled for October 7-10, 1996, in Freiberg, Germany. Hosts and coordinators for the Symposium will be the Ernst-Mach-Institut (EMI) and Institute de St. Louis (ISL). The Symposium Chairmen and the Technical Chairmen are listed near the end of the Newsletter. Stay tuned for additional details as they become available.

Standing Committees

Near the end of the Newsletter, there is a list of the standing committees. The committee memberships for the next term are now being formed. If you know of someone who you think should be active in the Society or be on a particular committee, please notify Dennis Orphal (phone: 510-460-0474; fax: 510-460-0449; e-mail: denny@calres.com). Self-nominations are also appropriate. As with all positions within the Society, committee membership is voluntary; there are no funds available to cover time or expenses.

Men stumble over the truth from time to time, but most pick themselves up and hurry off as if nothing happened. — Winston Churchill

THE PASSING OF GIANTS

Robert McQueen—Shock Physics Pioneer and Icon. With regrets, we announce the death of Robert Gregory McQueen on October 18, 1994, after a brief illness. Bob came to Los Alamos at the end of 1949. For most of his career he was in the Group first called GMX-6, then M-6, in Ancho Canyon. During the 50's and 60's he built up the capability for measuring the mechanical response of condensed matter to strong shocks produced most of the data in the compendium and entitled *LASL Shock Hugoniot Data*, published by the University of California Press. This compendium represents by far the most shock data available outside Russia. Bob had a keen insight into the behavior of materials under strong shock conditions, an insight based in part on a large number of experiments he and his group carried out. Rather than writing five papers on one experiment, Bob typically wrote one paper summarizing hundreds of experiments. Any paper he wrote or co-authored was a masterpiece of conciseness, but it was also demanding of the reader. Bob's attention to detail and reproducibility meant that there are still many experimental results in the files which have never been published. In addition to Hugoniot measurements, Bob's curiosity led him to devise means to get more information from shocked materials, including wave profiles, rarefaction wave velocities, and temperature measurements. One of his more spectacular experimental schemes used a thermite reaction over contained water to simulate certain volcanic eruptions. These were not always predictable, but certainly exciting. Bob's passing takes from the community one of the true leaders in the field of experimental shock wave measurements.

John Shaner
LANL

Editor's Note: In 1987, at the Fifth American Physical Society Topical Conference on Shock Waves in Condensed Matter, *Melvin H. Rice, Robert G. McQueen,* and *John M. Walsh* received the first *Shock Compression Science Award.* This award was presented for their outstanding contributions to the field of shock wave physics. In particular, they were cited for their 1958 review article, "Compression of Solids by Strong Shock Waves," (**Solid State Physics**, Vol. VI, Academic Press, NY, 1958). Their desire, as well as the wish of many others of the time, was to interpret and understand the response of materials to shock compression using the best hydrodynamics and thermodynamics possible. As George Duvall noted in his keynote talk at the 1985 Topical Conference: "[At that time] pressure was still one of the most neglected state variables in condensed matter physics. There were measurements by Bridgman, and very little else." (G. E. Duvall, "Shock Wave Research: Yesterday, Today and Tomorrow," in **Shock Waves in Condensed Matter**, pp. 1-12, Plenum Press, NY, 1986.) The pioneering work of Robert G. McQueen helped to open the door to the modern era of shock wave physics.

Sam Thompson—A Giant Force in Shock Code Development. Sam Thompson died on November 3, 1994 following a long battle against a rare form of cancer. Sam was a brilliant man by many measures. He also had a tremendous ability to develop reliable, robust, accurate computer codes. He developed this ability very early in his career and continued to nurture it to the end of his life. Sam had a long and distinguished career at Sandia National Laboratories, where he was the author or co-author of many strong shock physics codes. His codes stood the test of time because so many people found them accurate and robust. Sam manifested a fine craftsman's skill in his software. Sam understood the importance of writing portable codes and good post-processing codes. Sam strongly believed that supporting users, both inside and outside Sandia, was as important as writing good software. He worked exceptionally hard during his career to support his many users. Sam even somehow managed to find the time to write detailed reference manuals, some of which could serve as models for how to write good computer manuals today!

Sam joined Sandia in 1966 after earning a Ph.D. in astrophysics from the University of Kentucky, and began studying the response of materials to X-ray driven impulses. Sam wrote the 1-D CHARTD (Coupled Hydrodynamics And Radiation Transport-Diffusion) code soon after joining Sandia. It modeled strong shocks using the ANEOS equation of state package. Sam developed the ANalytic Equation Of State (ANEOS) package to model phase change phenomena. ANEOS did a remarkably good job of modeling thermodynamically consistent equations of state for many materials, including metals. ANEOS provided an equation of state

that was valid from room conditions to very high pressures and temperatures. After twenty-five years, we still use this code as a tool for quick generation of reasonably accurate equations of state.

Sam's most widely used code was Chart SQuared (CSQ). CSQ is a 2-D Eulerian code that modeled strong shocks, elasticity, plasticity, single-group diffusion radiation transport and fracture. Along with Matuska's HULL and Johnson's OIL codes, CSQ helped define the direction that all modern general purpose Eulerian shock wave physics codes would take in the 1980's and 1990's. It was truly a labor of love for Sam.

Sam's department developed the three-dimensional CSQ to the Three-Halves (CTH) code in the late 1980's. CTH is a 3-D, 2-D and 1-D Eulerian code that models strong shocks, elasticity, plasticity and fracture. Although Sam was a manager by this time, he still found time to develop much of the generator program (CTHGEN); CTHPLT, the post-processing program; and parts of the CTH program. Sandia, building on the user support philosophy that was so strongly a part of Sam's character, has currently distributed CTH to over 130 external users.

Sam was a major influence in shock physics and code development for almost thirty years. His influence and impact will be very difficult to match in the future. Sam was an inspiring colleague. His dedication, incredible productivity, and professional ideals allowed him to serve as a role model for many people working at Sandia. We will miss him.

Tim Trucano
Mike McGlaun
SNL

Editor's Note: The tribute to Sam Thompson is a condensed version of a longer testimonial to Sam's accomplishments provided by Tim and Mike. I can forward the longer version by e-mail to any who request it.

To get something done, a committee should consist of three people, two of whom are absent.
— Anonymous

NOTE FROM THE EDITOR

Journal Subscriptions

As a service to our membership, we have negotiated a special subscription price for the ***International Journal of Impact Engineering***. The Journal is now being published six times a year. The subscription cost for HVIS members is $85.00 for 1995 (Volume 16); this is approximately one-third the regular subscription costs. If you are not already signed up for the journal, please remit a check for $85.00, payable to the Hypervelocity Impact Society, and send the check with the mailing address for where you want to receive the Journal to:

Dr. Charles E. Anderson, Jr.
Southwest Research Institute
P. O. Drawer 28510
San Antonio, TX 78228-0510.

You will receive all issues for the current year with your subscription.

1994 Subscriptions

If you are interested in receiving the six issues for the 1994 volume (Vol. 15), please let me know. My e-mail is *canderson@swri.edu*, and my FAX number is 210-522-3042. The cost is $85.00. I will then process your request and you will then receive the back issues.

Reminder: Abstracts Due

Abstracts for the *1996 HVIS* are due by January 5, 1996. Abstracts should be limited to 1000 words plus figures and references. The abstracts must include authors names, affiliations and addresses. They should be submitted to:

Mrs. Susanne Deschoux
1996 HVIS
ERNST-MACH-INSTITUT
-Fraunhofer-Institute fuer Kurzzeitdynamik-
Eckerstr. 4
D - 79104 FREIBURG I. BR
GERMANY

Abstracts for the *16th International Symposium on Ballistics*, to be held in San Francisco (September 24-27, 1996) are due by January 12, 1996. These 300-500 word abstracts should be submitted to:

ADPA
BALLISTICS '96
Suite 400
2101 Wilson Boulevard
Arlington, VA 22201-3061

HVIS & IBC DATABASES

Åke Persson of Dynamec Research AB, Sweden, has developed a PC database (it operates under DOS or under WINDOWS) that includes the titles, authors, and the full abstract of all 400 papers published in the *HVIS-57, -59, -60, -62, -63, -65, -86, -89,* and *-92* symposia. *HVIS-94* will soon be implemented. The search program allows the user to search for words or parts of words, or combinations thereof, in the whole text. This database is fully compatible with the DTX/BALLISTICS database for the 15 *International Ballistics Symposia* organized during the period 1974-1995. Such a database might be of considerable interest to our membership. The prices are as follows:

1. **DTX/HVIS (9 symposia)**
   - Full price $395.00
   - HVIS attendees $160.00

2. **DTX/BALLISTICS + HVIS (15 + 9 symposia)**
   - Full price $645.00
   - IBC or HVIS attendees $260.00

3. **HVIS upgrade for DTX/BALLISTICS holders**
   - Full price $195.00
   - IBC or HVIS attendees $100.00

The price for future upgrades with abstracts from new symposia is $50.00.

If you are interested, you should contact:

Åke Persson
Dynamec Research AB
FAX No.: +46 8 550 60466
Tel. No.: +46 8 550 65323

HVIS STANDING COMMITTEES	Chairs
Awards Committee	James Wilbeck
Educational Outreach Committee	Gordon Johnson
Membership Committee	open
Nominations Committee	Don Shockey
Publications Committee	Charles Anderson
1994 Hypervelocity Impact Symposium	
Technical Chairman	Jim Asay
Symposium Program Co-Chairmen	Billy Hogan & Lalit Chhabildas
Symposium Coordinators	Alita Roach & Bill Deal
Commercial Exhibits Committee	Jim Ang & Dick Warnes
1996 Hypervelocity Impact Symposium	
Symposium Chairmen	A. J. Stilp (EMI), G.-A. Schröder (EMI), and H. Schulte (ISL)
Technical Chairmen	V. Hohler (EMI) and E. Schneider (EMI)

CALENDER OF RELATED CONFERENCES AND SYMPOSIA

Meeting	Location	Dates
Joint XV AIRAPT & XXXIII EHPRG International Conference	Warsaw, Poland	September 11-15, 1995
14th International Symposium on the Military Aspects of Blast and Shock	Las Cruces, NM	September 11-15, 1995
1995 Combat Vehicles Conference	Fort Knox, KY	September 18-20, 1995
AIAA Space Programs & Technologies Conference	Huntsville, AL	September 26-28, 1995
46th Aeroballistic Range Association Meeting	Alliant Techsystems Proving Grounds, Elk River, MN	September 17-22, 1995
IUTAM Symposium	Poitiers, France	October 2-6, 1995
Mines, Countermine & Demolitions	Tampa, FL	October 23-25, 1995
1995 ASME Winter Annual Meeting	San Francisco, CA	November 12-17, 1995
3rd Ballistics Symposium on Classified and Controlled Topics	Laurel, MD	November 14-15, 1995
First Australian Congress on Applied Mechanics	Melbourne, Australia	February 19-21, 1996
Mines, Countermine & Demolitions	Tampa, FL	October 23-25, 1995
6th International Conference on Numerical Combustion	New Orleans, LA	March 4-6, 1996
Materials Research at High Pressures, APS Meeting	St. Louis, MO	March 1996
7th TARDEC Ground Vehicle Survivability Symposium	Monterey, CA	March 26-28, 1996
5th Gordon Research Conference on Energetic Materials	New Hampton, NH	June 16-21, 1996
IUTAM Symposium	Dublin, Ireland	June 30-July 5, 1996
Structures Under Extreme Loading Conditions: ASME PVP Conference	Montreal, Canada	July 21-26, 1996
FRAGBLAST'5: 5th Int. Symp. on Rock Fragmentation by Blasting	Montreal, Canada	August 25-29, 1996
16th International Symposium on Ballistics	San Francisco, CA	September 24-27, 1996
1996 Hypervelocity Impact Symposium	Freiburg, Germany	October 7-10, 1996
47th Aeroballistic Range Association Meeting	ISL, St. Louis, France	October 14-17, 1996
XVI AIRAPT Conference	Kobe, Japan	1997
1997 APS Topical Conference on Shock Waves in Condensed Matter	Amherst, MA	July 27-August 1, 1997