HYPERVELOCITY IMPACT SOCIETY

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NEWSLETTER

1 + 1 + ... + 1 = 50 ENIAC: 50 YEARS SINCE DELIVERY

The 50th anniversary of the first electronic digital computer was recently celebrated. The Electronic Numerical Integrator and Computer, or ENIAC, was dedicated on Feb. 15, 1946 by Major General Gladeon Barnes, the head of Research and Development Service, Office of the Chief of Ordnance. Construction of ENIAC was funded by the U. S. Army Ordnance Department for the calculation of ballistic firing tables. Technical supervision of the project was given to the Ballistic Research Laboratory (BRL) at Aberdeen Proving Ground, MD.

Some background information helps to provide the proper perspective on the calculation of ballistic firing tables. First, what is a firing table? Goldstine[1] supplies a very nice summary.

> Basically, a gunner is in possession of one fundamental piece of information and a number of ancillary ones: the former is the location of a target and hence a distance (range) and an angle from, let us say, north. His gun however is in aiming respects like a surveyor's instrument in that it can be rotating both in a horizontal and in a vertical plane through predetermined angles. Thus he needs to convert his range into an angle in the vertical plane through the gun. This conversion is done by the firing table, the main functions of which is to tell the gunner at what angle to elevate his piece to reach a certain distance. This is necessary since, of course, one does not point a gun directly at a target. Instead, one fires up into the air, and the projectile arches up and then down in an orbit somewhat parabolic in shape. The horizontal angle, the azimuth, is directly measured and is determined purely geometrically. Secondarily, the gunner possesses certain other data that play a minor but not necessarily insignificant role: he is furnished with information as to head or tail winds, cross winds, air density and temperature—all as a function of altitude—the weights of his shells and propellant charges and their temperatures and possibly a few other facts. The tables enable him to factor these considerations into a final angle of elevation and angle of deflection.
>
> These tables sometimes existed as small booklets that fitted into a gunner's pocket or as automata—small highly specialized and usually analog computers—attached to guns, which accepted as input radar locations plus the secondary information. Bombing tables and bombsights were entirely analogous. Thus to make a long story short, there was a need to calculate these sorts of tables for every combination of gun, shell, and fuse.

A typical firing table required somewhere between 2000 and 4000 entries. Assuming 3000 entries, and a electromechanical calculator to assist the ballistician, it took approximately 750 hours—30, 24-hour days—to perform the trajectory calculations for a table. The automation of compiling ballistic firing tables was to be the *raison d'être* for the first electronic digital computer.

One of the main functions of the BRL during the 1940's was the production of firing and bombing tables and related gun control data. The Computing Branch at BRL had a staff of 176 people. It was taking three months of work on a two-shift basis to turn out the data needed to construct *one* firing table. The following quotation and table[1] appeared in a memo in 1944 to justify the need for continued efforts within the Ordnance Department to support development of electronic digital computing.

> The number of tables for which work has not been started because of lack of computational facilities far exceeds the number in progress. Requests for the preparation of new tables are being currently received at the rate of six per day.

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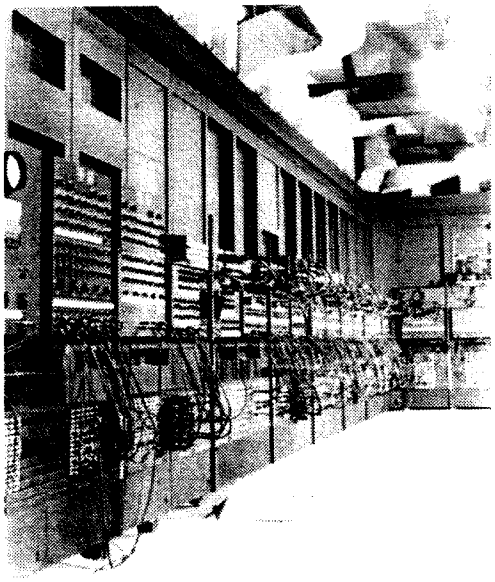
1 Herman H. Goldstine, *The Computer from Pascal to von Neumann*, Princeton University Press, Princeton, NJ, 1972.

	Completed	In Progress
Ground Gunfire Tables	10	16
Bombing Tables	1	28
Aircraft Fire Tables	3	16
Ballistic Tables	-	6
Miscellaneous Major Computations	1	8

Thus, the Army was on the lookout for a better, quicker and more accurate way to develop the firing tables. In April of 1943 a proposal to build an electronic computer was submitted to Colonels Leslie Simon and Paul Gillon[2] at the BRL. Work began 31 May, and a definitive contract was entered into on 5 June 1943. Col. Gillon named the proposed machine and gave it the acronym ENIAC. The University of Pennsylvania's Moore School of Electrical Engineering was given the responsibility of building the machine, under the direction of Lt. Herman Goldstine (a Ph.D. mathematics professor) as the appointed representative of the BRL, and John G. Brainerd, Director of the Moore School. Two of the most influential engineers in the actual construction of ENIAC were J. Presper Eckert and John W. Mauchly. Eckert was the chief engineer, and Mauchly was his consultant.[3]

Right from the start, Eckert understood that the overall success of the project was to depend entirely on a totally new concept of component reliability. Component failure was inevitable, and with 18,000 vacuum tubes, 70,000 resistors, 10,000 capacitors, and 6,000 switches, many people predicted that this machine would never calculate anything. Mauchly understood standard electromechanical machines of the period, and he was able to suggest to the engineers how to handle various design problems by analogy. Much of the credit for design and construction of ENIAC goes to Eckert and Mauchly.

ENIAC ended up 100 feet long, 10 feet high, and 3 feet deep. It weighed approximately 30 tons, and took 140 kilowatts of power to operate. Once turned on, ENIAC was not turned off since that would increase component failure. The failure rate was 2 or 3 tubes per week, and replacing a bad tube only took an hour or so, except when two tubes went bad at the same time (then diagnosing the problem took substantially longer). It turned out that ENIAC was not only much, much faster (at least 1000 times faster) than electromechanical machines, it was at least as reliable (electromechanical machines had a failure rate of somewhere between once a day to one or two per week). Speed and reliability guaranteed the utility of the electronic digital computer.



ENIAC was to be completed by September 30, 1945. As with many large projects, this deadline was not quite met. A problem from Los Alamos (the Manhatten Project) was used as the first test of ENIAC. Edward Teller was somehow involved in the problem; this is known because of correspondence between Goldstine and Teller dated November 23, 1945. We can only speculate as to the nature of the problem. The problem itself was classified as far as the underlying physical situation was concerned, but not as regards to the numerical or mathematical form of the equations to be solved. This "classification guide" is still pretty much in effect today. It is not clear how much von Neumann was involved, but he had a profound interest in numerical calculations and in hydrodynamics, and he provided a "fortuitous" link between BRL (he was on the BRL Scientific Advisory Committee) and Los Alamos (where he worked on the spherical implosion shock wave problem with Teller). Thus, it is not unreasonable to imagine that the Los Alamos problem was a spherical implosion...a one-dimensional hydro-

2 Col. Gillon was the assistant director of BRL under the Director, Col. Simon. Later, Gillon was Director of Research at Watertown Arsenal and then he founded and headed the Office of Ordnance Research, which was located on the campus of Duke University. This office subsequently became the Office of Army Research, and later, the Army Research Office (ARO).

3 In March of 1946, disagreements about who was responsible for the ideas and concepts underlying EDVAC (Electronic Discrete Variable Computer), the machine that was based on von Neumann's blueprint for digital computations, began to surface between von Neumann and Goldstine, on one hand, and Eckert and Mauchly on the other. These conflicts resulted in the deterioration of close relationships between these players, relationships that basically came to an end in April 1947. In October 1946, Eckert and Mauchly set up a partnership called the Electronic Control Company in Philadelphia. The partnership was reorganized into the Eckert-Mauchly Computer Corporation. The company received a contract from the National Bureau of Standards to build a machine for the Bureau of Census. The machine, UNIVAC (Universal Automatic Computer), built on EDVAC principals, was started in August 1947 and was operational in March 1951. In March of 1950, their company was purchased by Remington Rand, which merged with Sperry Gyroscopes in 1955 and became Sperry Rand.

dynamic code calculation. When the problem began running is not clear, but according to ENIAC log books, Problem A was running on December 10, 1945. On December 18, check run E was producing some wrong numbers. These were part of the Los Alamos problem, which were being used not only to obtain results for Los Alamos but to also find "bugs" in the machine.

A preliminary press conference was held on February 1, and a formal dedication of ENIAC was held on February 15, 1946 (some newspaper accounts say February 14). The demonstration problems were 1) 5000 additions in one second, 2) 500 multiplications in one second, 3) generation of squares and cubes, 4) generation of a sine and cosine table, and 5) a modification of the E-2 ENIAC run as an illustration of a long and complicated calculation.

ENIAC was formally accepted by the Government on 30 June 1946. On November 9, 1946, ENIAC was "turned off" so it could be moved to Aberdeen Proving Ground, where a new building had been constructed to house the computer (Building 128, the main building and entrance into BRL). It started up again on 29 July 1947. ENIAC continued to produce firing tables up to the time it was "retired". It's last calculation was on 2 October 1955, after which it was disassembled; a major portion was given to the Smithsonian Institution in Washington, D.C.

The computer has come a long way since then. The pioneering work of Goldstine, von Neumann, Eckert, and Mauchly has led to machines of incredible computational power, allowing simulations of complex material interaction problems. Such calculations have resulted in greater understanding of material response, and better designs of structural behavior. And these machines still calculate ballistic tables, so I guess we would view them as a success. On the other hand, they considered using ENIAC for weather forecasting.....

Charles Anderson and James Walker
Southwest Research Institute

I find the great thing in this world is not so much where we stand, as in what direction we are moving.—Oliver Wendell Holmes

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A NOTE FROM THE PRESIDENT

The *1996 HVIS* in Freiburg promises to be excellent, both technically and socially. We are very honored to have two simply outstanding Plenary Speakers: Andy Piekutowski of the University of Dayton Research Institute (UDRI) and Bill Nellis of the Lawrence Livermore National Laboratory (LLNL). Andy has spent much of his very distinguished technical career studying the behind-target debris cloud resulting from hypervelocity impact of a projectile on a thin target. Andy was very recently awarded the highest technical award at the UDRI, the Wohlleben/Hochwalt Award [more information concerning the award is given later in the Newsletter], for his overall work in hypervelocity impact and very specifically, debris clouds. Andy will give us a "tour de debris cloud" in his Plenary Lecture: *Formation and Description of Debris Clouds Produced by Hypervelocity Impact.*

As many of you probably already know, Bill Nellis and his team at LLNL recently announced the capture of a "Holy Grail" of high pressure physics. They have produced metallic hydrogen in the laboratory for the first time. They did it using a two-stage light-gas gun and some very special techniques, including using a 20-degree K liquid H_2 target. Metallic hydrogen was first predicted (I think) by Eugene Wigner (1963 Nobel Price in Physics) and Hillard Huntington in 1935. Many, many attempts have been made to produce metallic hydrogen. Now, over 60 years after the prediction, it appears that it has been made—and by "one of our own". Furthermore, the work of Bill's team seems to show, like all good experiments, not everything is as predicted. For one thing, the pressure required to make metallic hydrogen is lower than expected. This, using only a single example, has very significant implications for the structure of Jupiter. It is a great honor to have Bill present a Plenary Lecture: *Forming Metallic Hydrogen.*

See you in Freiburg.

Dennis Orphal
President

Opportunities are often disguised as hard work, so most people don't recognize them.—Ann Landers

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SOCIETY NEWS

1996 Hypervelocity Impact Symposium

The next *HVIS* is scheduled for October 7-10, 1996, in Freiburg, Germany. Hosts and coordinators for the Symposium are the Ernst-Mach-Institut (EMI) and Institute de St. Louis (ISL). The Symposium Chairmen and Technical Chairmen are listed near the end of the Newsletter. More information concerning the Symposium is provided later in the Newsletter.

Student Grants

Student Grants have been made available for the *1996 Hypervelocity Impact Symposium.* These grants are made available by the Hypervelocity Impact Society to encourage student interest and participation in this technology. The Student Grants cover transportation and lodging for the symposium, up to a limit of $1000 per grant. Free registration and a copy of the

proceedings are also provided. In addition, the students will have a short introductory meeting with HVIS Board and committee members.

Applications for the Student Grants consisted of a letter of recommendation from the Student's Advisor and included the following:

- Names, address, and telephone numbers of both the Student and the Advisor;
- A brief overview of the student's academic background and record;
- A description of future academic work to be pursued by the student;
- A discussion of why the symposium would be helpful for the student.

A total of 13 students representing 4 countries have applied and selection is in process.

Student Intern Program

The Hypervelocity Impact Society (HVIS) is introducing a Student Intern Program that will provide hypervelocity work experience and funding for undergraduate students who are in their junior or senior years.

The Student Intern Program will provide for 50 percent of a student's salary for a maximum duration of six months and/or a maximum payment of $3,000 (from HVIS). The host organization must provide the remainder of the student's salary. Details of the program are as follows:

- It will generally be the student's and/or the host organization's responsibility to find one another and establish a working agreement. The host organization could be a university, a government laboratory, a research institute, or an industrial organization.
- The host organization must make a commitment to provide interesting and challenging work related to hypervelocity impact.
- The student will be paid by the host organization under the employment and salary policies of the host organization.
- HVIS will pay 50 percent of the student's salary to the host organization (subject to the maximum duration and payment limitations) after completion of the term.

The student interns have been selected. They are as follows. Keith Burton, Simon Stephenson and Stephen Champion, who are all in their final degree year in Aeromechanical Engineering at the Royal Military College of Science in England. They will be working with three Ph.D. students and Professor John Hetherington characterizing the response of ceramics to impacts in the velocity range 1-4 km/s.

Sabrina Birnbaum, a Mech. Eng. junior at MIT, will be working at Century Dynamics on an advanced technique to increase significantly the "throughput" for numerical simulations of impact against space shields. She will also be working on development and implementation of SPH techniques into existing Euler/Lagrange codes.

Sean Bulla, a Mech. Eng. senior at U. Texas at Austin, will be working on a new thermal protection concept applicable to hypervelocity projectiles under the direction of Dr. Dennis Wilson.

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 the Internet, your e-mail address.

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 send a check 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) orders will be accepted provided the check follows promptly.

Standing Committees

Near the end of the Newsletter, there is a list of the standing committees. As with all positions within the Society, committee membership is voluntary; there are no funds available to cover time or expenses. We thank these people for their time and dedication. It is the Society members that MAKE the Society.

The optimist proclaims that we live in the best of all possible worlds; and the pessimist fears this is true.—James Branch Cabell

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ELECTIONS FOR THE BOARD OF DIRECTORS

The HVIS Board of Directors is the governing body of the Society, and as such administers the property and funds, appoints the committees, determines member privileges and dues, conducts the publication program, and determines and arranges for Society meetings.

In accordance with the Constitution of the Society, two positions on the Board of Directors will be open this October at the time of the *1996 Hypervelocity Impact Symposium*. The Nominations Committee has proposed a slate of six candidates and the prospective candidates are being contacted to obtain their concurrence to run for election. Ballots, containing brief biographical resumés of each of the candidates, will be mailed to the Society membership this summer. **Be on the lookout for your ballot.** The results of the voting will be announced at the *1996 HVIS* in Freiburg.

Don Shockey
Chairman, Nominations Committee

1996 HYPERVELOCITY IMPACT SYMPOSIUM

As reported in the last Newsletter, the Paper Selection Committee met in Freiburg at the end of January to review and discuss submitted abstracts. One hundred twenty-eight abstracts, from 11 countries, were submitted for consideration. This was a very encouraging response since the Symposium is being held outside the USA for the first time. Of the 128 abstracts, 110 were tentatively accepted and 18 were rejected (8 papers of the 110 were asked to combine their papers into 4; thus, 106 possible papers existed).

It was noted, however, that final acceptance of a paper occurs only after submission of a draft manuscript and peer review. The purposes of peer review are to ensure significant technical content and applicability of the research for presentation at the Symposium; and to improve the overall technical quality of the manuscripts. The proceedings, as before, will be published as a special volume of *International Journal of Impact Engineering*. The policy of the Journal is that all articles must be reviewed and accepted by two knowledgeable reviewers.

The Symposium committee takes the responsibility of peer review very seriously. All draft manuscripts were reviewed by a minimum of two reviewers, and in many cases, by additional reviewers. As a result of the review process, articles could be 1) accepted with minor revisions; 2) accepted with essential revisions; 3) accepted only after a major revision and subsequent review; or 4) rejected. A listing of the numbers of manuscripts by topical category is given in the Table at the top of the next page. As can be seen, acceptance of an abstract does not ensure acceptance of the paper; and from experience with the previous Hypervelocity Symposia, some of the "resubmits" will not make the Symposium.

Tentatively, there will be approximately 43 oral presentations and 40 poster presentations. In addition, about 10 exhibitors are expected. The exhibitors are research institutes and firms who will provide information about their work and progress in experimental techniques and diagnostics.

Besides the papers in the regular program, there will be the Distinguished Scientist Keynote, and two planned plenary talks. A special (classified) session will be held at the Institut Franco-Allemand de Saint-Louis (ISL) on Friday, October 11. There were 15 papers submitted for this session. Four were rejected; two were required to resubmit their manuscripts, and nine were accepted. Thus, there is the potential for eleven papers at the special session. Specific information about the special session at ISL may be obtained from Dr. Hartmuth Lehr (Institut Franco-Allemand de Saint-Louis, 5 rue du Général Cassagnou, Boite Postale 34, F68301 Saint-Louis, France).

The new *Konzerthaus Freiburg* Conference Center opened June 28, 1996. The *1996 HVIS* is one of the first major events scheduled for the new Conference Center, but since there are several events taking place prior to the *1996 HVIS*, things should run smoothly for us. The Organizers have arranged a reception by the city of Freiburg in the historic trade center built in the 16th century, on Tuesday, October 8, at 6:30 p.m. A banquet is organized for Wednesday night; special food and wine from the area will be offered. A highlight of the banquet evening will be a talk by Professor Stöffer from the Humboldt University in Berlin, a well-known mineralogist/planetologist. He has many publications on meteoroid impact, and is an expert on planetary impact features. He will speak about "The Nördlinger Ries Formation by a Great Impact Event."

The "Historic Train" trip, after completion of the technical sessions on Thursday, will offer additional time for discussions, talking, congratulatory remarks, fishing for compliments, etc. The train itself is pulled by a steam engine which is called "Rebenbummler" because it travels slowly through the wine-hills of the Kaiserstuhl area. The scenic Kaiserstuhl landscape is actually an ancient volcanic area; it is the warmest place in Germany and is famous for its wines. The tour includes a reception at the Badischer Winzerkeller in the small town of Breisach, near the Rhine, to taste local wines.

An attractive companion program will also be offered. There are various possibilities, since Freiburg and the Black Forest are a tourist region and close to France and Switzerland.

The Organizers would also like to mention the 47th Meeting of the Aeroballistic Range Association to be held one week later at the French-German Research Institute in Saint Louis, France. Saint Louis can be reached in one hour by car from Freiburg. This invites the attendees to extend their stay in the nice region of the cities Freiburg - Basie - Mulhouse.

A. J. Stilp; V. Hohler; E. Schneider
Ernst-Mach-Institut

Cessation of work is not accompanied by cessation of expenses.—Cato the Elder

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HOW TO REACH FREIBURG

There are a number of ways for reaching Freiburg.

Airports: Frankfurt, Basel (the closest airport), Zurich

Basel is very convenient for European travellers, but not as convenient for international travellers since it would mean a change in planes.

Train: There exist fast Intercity Train connects from Frankfurt (2.5 hours), and Zurich (2 hours) to Freiburg/Br.

Bus: An Airport bus runs between Basel and Freiburg (Main Train Station)

The Conference Center is located just *vis á vis* the Main Train Station.

Car: From all destinations, Freiburg can be reached via the Autobahn.

Once in Freiburg, it is recommended that you not have a rental car. Freiburg is a "Green City," and parking is extremely limited, and quite expensive. All planned events are within easy walking distance of the Conference Center and the intercity hotels. Bus transportation will be provided for the Museum Train Ride (Thursday), and from Freiburg to ISL for the Special Session on Friday.

Few things are harder to put up with than the annoyance of a good example.—Mark Twain

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NOTES FROM THE EDITOR

News About Members

This is a feature started a couple of issues ago to highlight recognition of our membership. Please report any awards, special recognition, election to office, etc., to the Editor of the Newsletter. Thanks.

Andrew J. Piekutowski. The University of Dayton annually awards the Wohlleben/Hochwalt Award to a member of the full-time research staff in recognition of an outstanding accomplishment during the preceding three years. The Wohlleben/Hochwalt Outstanding Professional Research Award is given to an individual or team for a significant accomplishment in basic, applied, or development research. The significance of the accomplishment is demonstrated by a combination of the following: submission of a technical report, publication in a professional journal, granting of a patent, presentation before a technical or professional society, national or international recognition for a technical accomplishment, or other evidence of technical excellence that is characteristic of a particular field or discipline. A committee made up of members of the research staff, appointed by the Director, recommends the winner of the award from nominations submitted by members of the staff. The award is dedicated to Brother William Wohlleben, the first American member of the Society of Mary to receive a Ph.D. and his student, Dr. Ted Hochwalt, UD alumnus, inventor with 80 patents, and former Vice President for Research for Monsanto Chemical Company.

This year's award was bestowed on Andy Piekutowski for his work on debris clouds resulting from the hypervelocity impact of a projectile on a thin target.

James D. Walker. The Materials and Structures Division at Southwest Research Institute (SwRI) presented James with the *1995 Scientific Achievement Award* for significant contributions in computational constitutive response modeling and fundamental advances in penetration mechanics.

Charles E. Anderson, Jr. The Materials and Structures Division at SwRI presented Charlie with the *1995 Technical Leadership Award* for his leadership of a vigorous high quality program in engineering dynamics and ballistics.

Draft Manuscripts Submitted for *1996 HVIS*

	Totals	Accepted	Resubmit	Rejected
Launchers and Diagnostics	12	6	4	2
Planetary Impact	5	4	1	0
Penetration Mechanics	15	11	3	1
Fracture and Fragmentation	7	5	1	1
Debris Shields & Spacecraft Impact				
Shielding	11	8	2	1
Pressure Vessel	7	5	2	0
Spacecraft	8	6	2	0
Hypervelocity Phenomenology	10	6	2	2
Numerical Algorithms & Simulations	14	11	3	0
TOTALS	89	62	20	7

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 eight times a year. The subscription cost for HVIS members is $95.00 for 1996 (Volume 18); this is approximately one-quarter the regular subscription costs. If you are not already signed up for the journal and wish to receive the subscription, please remit a check for $95.00, 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.

HVIS STANDING COMMITTEES	**Chairs**
Awards Committee	James Wilbeck (Kaman Sciences)
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Nominations Committee	Don Shockey (SRI)
Publications Committee	Charles Anderson (SwRI)
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)

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, -92* and *-94* symposia. 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 (10 symposia)**
   - Full price $395.00
   - HVIS attendees $160.00

2. **DTX/BALLISTICS + HVIS (15 + 10 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:

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CALENDER OF RELATED CONFERENCES AND SYMPOSIA

Meeting	Location	Dates
IUTAM Symposium	Dublin, Ireland	June 30 - July 5, 1996
SUSI '96: 4th Int. Conf. Structures Under Shock and Impact	Udine, Italy	July 3-5, 1996
ASME Fluids Engineering Division Summer Meeting	San Diego, CA	July 7-11, 1996
Structures Under Extreme Loading Conditions: ASME PVP Conference	Montreal, Canada	July 21-26, 1996
3rd International Conference on Composites Engineering	New Orleans, LA	July 21-27, 1996
3rd International Conference on Computer Simulation of Radiation Effects in Solids	University of Surrey, Guildford, UK	July 22-26, 1996
Characteristics and Consequences of Orbital Debris and Natural Space Impact Conference (SPIE Symposium)	Denver, CO	August 4-9, 1996
DOD Explosives Safety Board (DDESB) Meeting	Las Vegas, NV	August 20-22, 1996
Ground Target Modeling & Validation Conference	Houghton, MI	August 20-22, 1996
FRAGBLAST'5: 5th Int. Symp. on Rock Fragmentation by Blasting	Montreal, Canada	August 25-29, 1996
Int. Conf. on Shock Waves in Condensed Matter	St. Petersburg, Russia	September 2-6, 1996
16th International Symposium on Ballistics	San Francisco, CA	September 23-25, 1996
Space Protection of the Earth (SPE-96)	Snezhinsk (Chelyabinsk-70), Russia	September 23-27, 1996
Symposium on Structures Response to Impact and Blast	Tel Aviv, Israel	October 6-11, 1996
1996 Hypervelocity Impact Symposium	Freiburg, Germany	October 7-10, 1996
47th Aeroballistic Range Association Meeting	ISL, St. Louis, France	October 14-17, 1996
14th Army Symposium on Solid Mechanics	Myrtle Beach, SC	October 16-18, 1996
International Conference on Condensed Matter Under High Pressures	Bombay, India	November 11-15, 1996
FAA International Symposium on Explosives Detection Technology	FAA Tech Center, Atlantic City, NJ	November 12-14, 1996
IMPLAST '96: Symposium on Plasticity and Impact Mechanics	New Delhi, India	December 11-14, 1996
ADPA/AIAA Live Fire Test and Evaluation Conference: 10 Years and Counting	Livermore, CA	January 13-17, 1997
1997 APS Topical Conference on Shock Waves in Condensed Matter	Amherst, MA	July 27-August 1, 1997
Joint XVI AIRAPT Conference and 38th High Pressure Conference	Kyoto, Japan	August 25-29, 1997
11th Detonation Symposium	Aspen, CO	August 30-September 4, 1998

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