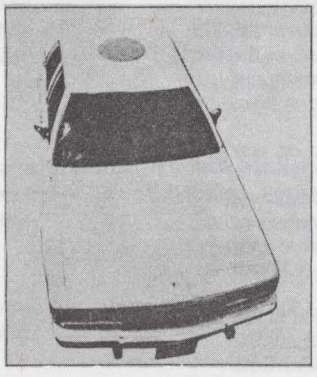
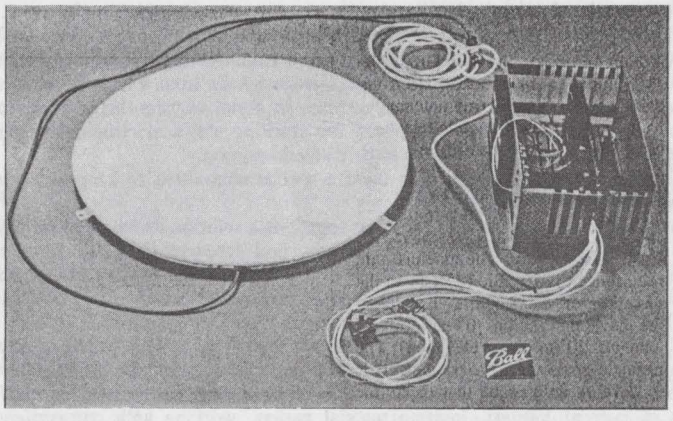
IEEE
VEHICULAR TECHNOLOGY SOCIETY
NEWSLETTER

Vol. 36, No. 1, February 1989 ISSN 0161-7887 Editor: A. Kent Johnson

Mobile/Satellite Communications Advances





Electronically controlled phased-array antenna for mobile satellite-telephone use

More about the cover on page 12

President's Message

George McClure
President
IEEE Vehicular Technology Society

As your incoming president, I recognize both the challenge and the opportunity presented to me. The challenge is to maintain the high standards set by my predecessors, particularly Stuart Meyer who has just completed his second term of office, and to be responsive to the needs of the membership. The opportunity is provided by the increasing presence of vehicular technologies in the lives of the public, who are unaware of the engineering that has made new marvels available to them now, with the prospect for even more convenience in the future.

The growth of analog cellular mobile telephone threatens to outstrip spectrum capacity, providing an incentive to set standards in the near term for a more spectrum-efficient digital cellular service. We are planning a special issue of our Transactions on this topic.

As economies of scale in production of portable communications equipment are realized, coupled with steadily declining components costs, the demand for personal communications services will increase. Already, we have newspaper reporters filing stories direct from courtrooms on their portable cellular phones, and lawyers taking calls on their's while having breakfast at a restaurant. School children are wearing radio pagers, allowing contacts from their homes or after-hours jobs.

Vehicular electronics is growing as well, with computers for engine ignition, emission control, and anti-skid braking control appearing in more and more automobiles and commercial vehicles. The technology used for electric vehicles is being considered on a larger scale to provide electric propulsion systems for navy warships, replacing steam turbines and diesel power plants. A by-product is the availability of more electric power for shipboard weapon systems.

Vehicle navigation systems are finding more commercial applications, such as fleet control and monitoring, in addition to military vehicle and scientific applications. An example of the latter is a whale monitoring system that tracks radio signals from a transmitter located on the dorsal fin. When the fin breaks the sea surface, its signal triggers the on-board recording of date, time, and position information from the tracking ship's electronic navigation system, allowing the migration habits of whales to be studied accurately.

Bob French has been appointed to head a special committee to keep us current on new developments in vehicle navigation.

A resurgence of interest in light rail mass transit as a solution to the need for people movers that can bypass our automobile-clogged streets and freeways is being complemented by commercial interest in magnetic levitation transit systems. One maglev system under serious study by a West German firm would provide rapid transit between Florida's Walt Disney World and the Orlando International Airport.

Your Transactions staff is reorganizing to more effectively provide timely publication of the increasing volume of archival papers of interest to our membership. Dr. Bill Lee now heads the Publications Committee, with responsibilities for coordinating special issues of the Transactions on topics of current interest, inviting tutorial papers, working with our conference papers committees, and identifying subjects for VTS-sponsored books to be offered by IEEE Press.

Dr. Sang B. Rhee has assumed the duties of Transactions Editor, where he is assisted by J.R. Curz as Communications Associate Editor, Dr. Giorgio Rizzoni as Vehicle Electronics Associate Editor, and Dr. Richard A. Uher, of the Land Transportation Committee, as Transportation Systems Associate Editor. Dr. Rhee intends to expand his staff further, including overseas editors, to speed papers processing.

Dr. Kent Johnson will continue his fine work in editing our Newsletter, keeping us posted on current events and chapter activities.

Following a landmark vehicular technology conference in Philadelphia last year, we are looking forward to an even more comprehensive conference in San Francisco this year. Frank Thatcher, the 1989 conference chairman, reports that 150 papers from 17 countries will be presented--a scope that is unprecedented. Mark your calendar to attend this exciting conference this spring.

One last thought. Our strength is in our membership. Volunteers steer our activities to be responsive to member needs and desires. How can you help? Encourage your associates to become members of VTS. Establish or strengthen a local chapter through your interest and participation. Communicate your willingness to serve on a VTS committee covering an area of interest to you or, if none exists, offer to spearhead a new committee in that area. If you are interested, other members will be too. I will appreciate your comments and suggestions as we break new ground this year.

George F. McClure

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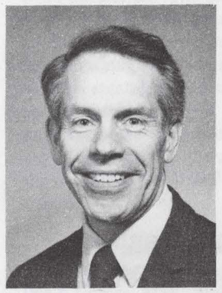

A. Kent Johnson
Newsletter Editor

We hope that this edition of the newsletter finds each of you looking forward to the upcoming VTS conference which will be held this year at the Sir Francis Drake Hotel in San Francisco from April 29 to May 3, 1989. Elsewhere in the newsletter you will find more information about the conference. Many outstanding technical papers have been submitted by authors from fourteen countries and it looks like it will be an outstanding conference. We look forward to seeing you there.

We would also like to extend sincere congratulations to three members of IEEE/VTS who were recently elected to Fellow Grade in the IEEE. They are:

Kamilo J. Feher:
For contributions to digital communications research and for leadership in applied communications engineering education.

Luther G. Schimpf:
For contributions to the digital transmission of speech.

We are proud to have these individuals as members of VTS and congratulate them on their accomplishment.

Finally, we would like to congratulate 5 members of our society who were elected to our Board of Governors as a result of the election last fall. They are:

Robert E. Fenton
Robert A. Mazzola
George F. McClure
Stuart Meyer
Jesse E. Russell

We look forward to working with these individuals in the 3 years ahead. Their terms began on January 1, 1989.

Month of Issue	Final Copy to be Rec'd By VTS Editor	Target Mailing Date
May	3-10-89	4-14-89
August	6-9-89	7-14-89
November	9-15-89	10-13-89
February	12-29-89	1-31-90

Chapter News

Gaspar Messina
Chapter News Editor

Meetings

San Francisco Bay Area VTS

Subject: Practical Comparison of Transmitter Simulcast and Following Voted Receivers
By: Mr. Preston Thomson
Communications Director
Sonoma County, California
Held: January 12, 1988
Attendance: 12 (2 guest)

Subject: Testing For The FCC Equipment Authorization Program
By: Mr. R. W. Johnson, P.E.
2820 Grant Street
Concord, California 94520
Held: February 9, 1988
Attendance: 19 (6 guests)

Subject: History of Land Mobile
By: Mr. Stuart Meyer, President
Vehicular Technology Society
Vienna, Virginia
Held: December 15, 1988
Attendance: 17 (5 guests)

Philadelphia VTS

Subject: AMTRAK'S CETC System For Controlling Traction Power and Trains On The Northeast Corridor
By: Mr. Andrew L. Jones, Engineer
SC & DA Systems, National Railroad Passenger Corp.
2000 Market Street, 6th Floor
Philadelphia, PA 19103
Held: December 15, 1988
Attendance: 13 (1 guest)

New Jersey Coast AES/EMC Chapter

Subject: The Army Frequency Allocation Process
By: Mr. Paul A. Major
U.S. Army Command
Fort Monmouth, NJ 07703
Held: October 17, 1988
Attendance: 20 (1 guest)

Toronto Section VTS

Subject: Land Mobile Communications
By: Mr. Stuart Meyer, President
Vehicular Technology Society
2417 Newton Street
Vienna, Virginia 22180
Held: October 26, 1988
Attendance: 16 (8 guest)

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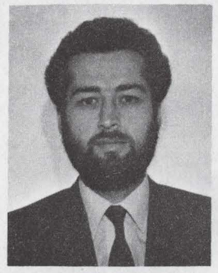
Communications



J. R. Cruz
Communications Editor

ABSTRACTS

"Satellite Mobile Communication and Radio Positioning System Planning Aspects," K.G. Johannsen, I.E.E.E. Trans. Aerospace Electron. Syst., Vol. 24, No. 4, July 1988.

In recent years a number of satellite mobile radio systems have been designed and slowly some of these systems are approaching realization. In the United State, the Federal Communication Commission (FCC) has encouraged industry to come forward with possible design concepts, and United States and Canadian industry have responded with responsive filings. Recent FCC action has allocated frequency bands at UHF and L–band. While most systems provide telephone and message traffic, some also provide radio position determination or position locationing and therefore require two or more active satellites.

System aspects of mobile communication and position determination by satellite are presented. Topics of discussion are the choice of frequency, type of modulation/multiple access and system design, and considering the effects of active and passive intermodulation and multipath interference.

Communication performance and position determination analyses are conducted with respect to small scale domestic mobile communication systems, where the satellite mobile transponder constitutes only a fraction of the otherwise fixed service C–band or Ku–band payload, and where the orbit position of the spare satellite(s) is dictated by considerations other than purely radio positioning.

The system tradeoffs and arguments presented lead to a particular modulation multiple access system, which provides high channel capacity, good ranging accuracy and high resistance to multipath fading.

"Simultaneous Voice and Data Transmission in Private Mobile Radio Using a Narrowband FM Channel," M.O. Al–Nuaimi, and M. Charnley, IEE Proc., Vol. 135, Pt.F, No. 5, October 1988.

Despite the arrival of cellular radio, private mobile radio (PMR) will continue to be the main provider of mobile communications to a number of important users, particularly in areas outside the main urban centres. The release of Band III for mobile radio services constitutes a significant factor in alleviating the spectrum shortage and should act as a spur for the development of new systems of spectrum utilisation. The paper discusses an integrated system for voice and data transmission using a number of novel modulation strategies suitable for multiplexing speech and data on a single 12.5 kHz mobile radio channel. Evaluations of these strategies and their implications for system design are conducted using a novel CAE simulation tool. The simulation shows that one of these modulation schemes is highly suitable for simultaneous voice and data transmissions. This is confirmed by experimental measurements on a prototype system.

"A Framework for Defining the Quality of Communications Services," J.S. Richters and C.A. Dvorak, IEEE Comm. Mag., Vol. 26, No. 10, October 1988.

In this paper we have attempted to derive a quality definition framework broad enough to capture any and all criteria that customers use in judging the quality of the service they receive.

An additional benefit experienced with the use of this framework is a more consistent, disciplined analysis of service parameters. This adds to the thoroughness with which service providers and customers alike assess the quality of communications services. Thus, by the very act of using this framework, customers can begin taking the initiative in defining quantitative service quality parameters for the performance attributes of most value to them, and providers of communications equipment and services can more systematically determine how well their products will meet customer needs.

"A Simple Prediction Method for L–Band Multipath Fading in Rough Sea Conditions," Y. Karasawa, and T. Shiokawa, IEEE Trans. Commun. Vol. 36, No. 10, October 1988.

Quantitative analysis of the coherent and incoherent power of sea reflected waves at 1.5 GHz was performed based on the multipath fading data obtained by field experiments. The experiments were carried out by using shore–to–shore, satellite–to–shore, and satellite–to–ship paths, and antennas with gains from 13 dBi to 21dBi were used for signal reception. Results indicate that, in rough sea conditions where the incoherent component is dominant, the power of the incoherent component can reach the maximum power of the coherent component (generated in calm sea) in most cases, except for a few cases such as when measured by using narrow–beam antennas or elevation angles below 7°. Based on the results obtained, a simple prediction method of mutipath fading caused by sea reflection is presented.

"PSK and DPSK Trellis Codes for Fast Fading Shadowed Mobile Satellite Communication Channels," P.J. McLane, P.H. Wittke, P.K.M. Ho, and C. Loo, IEEE Trans. Commun., Vol. 36, No. 11, November 1988.

The performance of 8–PSK and 8–DPSK trellis codes is presented for a class of fast fading, land mobile satellite communication channels. As presented in the literature, the fading model is Rician but in addition, the line–of–sight path is subject to a fast lognormal attenuation that

represents tree shadowing. The fading parameters used in this study represent the degree of shadowing and are based in measured data. The primary application considered here is for digital speech transmission and thus, bit error probabilities in the order of 10^{-3} are emphasized. Sensitivity of the bit error probability to amplitude fading, amplitude and phase fading, and decoding delay is presented. Performance is determined via digital computer simulations. Optimal four– and eight–state codes are determined and optimality is found to be dependent on the presence of log-normal shadowing.

"Performance of Trellis Codes for a Class of Equalized ISI Channels," L.N. Wong and P.J. McLane, IEEE Trans. Commun., Vol. 36, No. 12, December 1988.

It is now well known that Unbgerboeck's trellis codes can be employed to improve the performance of equalized voiceband data channels. In this paper, the performance of such codes is examined for a class of intersymbol interference (ISI) channels that occur in high frequency (HF) radio systems. The channels considered are characterized by in–band spectral nulls and by a rapid time variation. The baseline modulation technique is 4–point, quadrature amplitude modulation (4 QAM). When spectral nulls are absent, performance of fractionally spaced linear equalizers and trellis decoders is found to be near ideal and to be better than using symbol-spacing in the equalizer. However, error propagation in the feedback path, resulting from equalizer-based decisions ruins the performance of the combination of decision feedback equalizers and trellis decoders when spectral nulls are present. Their performance can be improved by using fractionally spaced feed-forward equalizer sections and by designing the decoder to compensate for ISI. Rate 2/3 codes are found to outperform 1/2 codes in error performance.

"Level Crossing Rate and Average Fade Duration for Time Diversity Reception in Rayleigh Fading Conditions," F. Adachi, M.T. Feeney, and J.D. Parsons, IEE Proc., Vol. 135, Pt.F., No. 6, December 1988.

Time diversity, in which the same data are transmitted several times, is attractive in digital land mobile radio and is simple to implement because only one antenna is required. Expressions for the level crossing rate (LCR) and average fade duration (AFD) are derived in this paper for a system in which each data symbol is transmitted twice (two–branch diversity). As far as LCR is concerned, the expected diversity advantages can be obtained for a data repetition period, normalized by the maximum Doppler frequency of about 0.2. For a large data repetition period, the AFD is halved. Measured values of LCR and AFD, obtained from 900 MHz signals received at a base station site, are in good agreement with the predicted values.

"Performance of Time–Frequency Coded Spread Spectrum Systems Operating Over Noisy Fading Channels," P Belezinis, and L.F. Turner, IEE Proc., Vol. 135, Pt. F, No 6, December 1988.

The performance of time frequency coded spread spectrum systems (TFCSSS) is considered when the systems are operating over noisy fading channels. Systems employing the random addressing technique of Viterbi [1] and the addressing scheme developed more recently by Einarsson [3] are examined. An exact expression is derived for the word–error probability associated with the Viterbi scheme. This expression provides the tightest known upper bound to the performance of the Einarsson addressing scheme. Also in the paper the question of the most appropriate way of using power is considered, and it is shown that if the possibility of using an increased transmitter power exists, it is better to increase the power per transmission chip to a higher level and keep it constant irrespective of the number of users occupying the chip, rather than to use a power level that increases with the number of users occupying the chip.

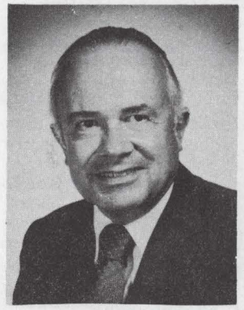
"Performance of Slot Synchronous Time–Frequency Coded Spread Spectrum Systems," P. Belizinis, L.F. Turner, I.M.I. Habbab, IEE Proc., Vol. 135, Pt. F, No. 6, December 1988.

The operation of slot synchronous time–frequency coded spread spectrum systems is considered, and an exact closed–form expression is derived for the probability of error. This exact expression is, in general, very difficult to evaluate, and as an aid to estimating system performance, three new upper bounds are derived. These bounds are such that the degree of difficulty of computation increases with increasing tightness of the bounds. The bounds are, however, all relatively easy to evaluate. Simulation results relating to error probabilities are presented and compared.

"Optimum Threshold Diversity Reception of Binary Noncoherent Frequency Shift Keying," A.M. Maras, H.D. Davidson, and A.G.J. Holt, IEE Proc., Vol. 135, Pt. F, No. 6, December 1988.

The optimum diversity rule for reception of binary noncoherent frequency–shift keying in slow and nonselective Rayleigh fading (multipath) and additive non–Gaussian noise is derived for the critically important threshold case (of small nonvanishing signals and large sample size). The relevant expression for the probability of error illustrates the significant improvement achieved, even with a small number of diversity channels, i.e. 20–30 dB gain from two to five channels for 10^{-5} error probability.

Professional Activities



Frank E. Lord
Professional Activities Editor

Professional Issues and The Fallacy of Composition

Considerable difference of opinion exists, even among ourselves, about significant issues that affect our profession. These issues include international competitiveness, offshore manufacturing, age discrimination and pre-college science and math education. One of the great sources of confusion when considering these issues is a lack of understanding of the concept of fallacy of composition.

The eminent economist Paul A. Samuelson provides an excellent exposition of this principle in his classic introductory text, **Economics.** This long recognized principle states that what is the best tactic for a single entity is not usually the best for the whole group. The classic example involves individual savings rate and the collective savings rate of the nation. Or think of a company of soldiers with each man crouching deep in his fox hole minimizing his chance of being wounded while the whole company is overrun because no one was taking the risk required to shoot back. Samuelson uses a more peaceful example of standing on tiptoes to better see a parade. It works fine for a few people, but if everyone does it no one sees any better and they are all straining harder. What could be more counterproductive for everyone?

In American industry and business the tendency to overly concentrate on the present does not create an environment that leads to a favorable long term competitive position. It is more like strip mining. You make money now and then walk away from the ruins. However, this behavior is easy for individuals and individual organizations to rationalize. In this general environment there is less need for engineers because their work for the most part is in areas of endeavor associated with long term benefits.

The same dilemma exists with respect to the choice between off shore and domestic manufacturing. What may seem advantageous to an individual entity is a disadvantage for the country collectively. For an excellent up to date exposition of this subject read **Manufacturing Offshore is Bad Business** by C.C. Markldes and N. Berg in the September-October 1988 issue of Harvard Business Review. In this article the authors present convincing arguments for the following points:

- The savings can cost a lot
- You don't really save much on labor
- You'll hollow the corporation
- The advantage doesn't last
- You may get trapped
- You'll lose valuable friends at home

They also cite companies like Kodak and Black & Decker for their success at competing by manufacturing at home.

Let us consider age discrimination. Here companies operating on some already shaky perceptions decide not to hire older people. Individual companies may achieve some advantage in doing this although that is open to considerable question. However, if all companies followed this practice we would suffer collectively form the loss of a valuable production resource, higher costs for social programs, and loss of a market.

We are all aware of the institute's program to encourage better education in science and mathematics at the pre-college level. If this is done because we want to produce more informed citizens who can understand major technological issues that face the country and act intelligently on them, that is one matter. However, if we are doing this because we think we need such trained young people to be qualified to enter college level science and engineering ciricula because they will all be needed to fill our future needs for scientists and engineers, that is quite another matter. The more successful we are in this latter regard, the more disappointed young people there will be and the less attractive these professions will look to the truly promising and gifted students. It is easy to understand how an individual young person could benefit from better preparation in science and mathematics, but the principle of fallacy of composition warns us that there are possible pitfalls and that the overall effort could be counter productive. Here we have an effort that has not been examined from the collective point of view. The lab in which this experiment is being conducted involves thousands of real people and the experiment consumes years of time.

As always, comments from readers are welcome.

Transportation Systems

Bob McKnight
Transportation Systems Editor

FRA holds inquiry on use of event recorders on railroads' locomotives

Federal Railroad Administration held a hearing on January 10, 1989 in which it was seeking information from the nation's railroads "to determine whether Federal regulatory intervention is necessary to ensure the presence of event recorders on train movements within FRA's jurisdiction and whether such regulations would be cost beneficial. The proceeding will also explore whether there is a necessity for standards governing event recording devices."

NOTE: Publication deadline requires that this is being written before the hearing. However, material is taken from FRA's Advance Notice of Proposed Rulemaking and answers by Association of American Railroads to FRA questions about event recorders.

Specifically, FRA is seeking information concerning current extent of event recorder installation, the capabilities of event recorders in current use, anticipated technological developments and potential uses of event recorder data.

Preliminary review by FRA shows that every major railroad now uses event recorders of some type; because technology has been advancing rapidly in this area, these devices vary considerably in both the number and type of "events" they will record. In the railroad environment, it may not be necessary to equip every locomotive to ensure that every train movement is recorded-monitored, since most movements employ multiple locomotives in addition to the "central" or "lead" locomotive. Overall more than 7,500 of the approximately 17,000 road locomotives owned by the major United States railroads are so equipped. In at least one individual fleet, more than half of the locomotives have recorders.

The majority of the recorders now in use have the capacity to record the following eight events over a 48-hour period:

1. Time.
2. Speed.
3. Traction motor amperage.
4. Distance traveled.
5. Throttle position.
6. Dynamic brakes.
7. Locomotive (independent) brake,
8. And train brake pipe pressure reduction.

More advanced recorders are now available and some of these will record 20 or more events; devices using magnetic tape as the recording medium are now meeting competition from devices which record into a computer readable memory, facilitating direct computer analysis of the events leading up to an accident.

Event recorders have long been a useful tool to FRA investigators in determining accident causation, but we intend in this procedure to go beyond our anecdotal experiences to solicit comments on the following issues (says FRA in its Federal Register notice of November 23, 1988):

FRA: What percentage of the current locomotive fleet is equipped with some form of event recorder? How does that percentage vary among the following categories:

-- Class I carriers
-- Regional railroads
-- Short line carriers
-- Locomotives moving Amtrak equipped (whether owned by Amtrak or not) trains

AAR: Among Class I carriers, approximately one-third of the road locomotive fleet is equipped with event recorders. It is estimated that over 80% of all mainline train movements are being covered.

Although currently accurate figures should be obtained from representatives of these organizations, we know that some regional railroads, short line carriers and commuter carriers have locomotives which are equipped. The preponderance of Amtrak trains now operate with event recorders.

FRA: What percentages of the fleet would have to be equipped to ensure that all train movements subject to FRA jurisdiction are recorded? Does that percentage vary among the classes of carriers described in the question above?

AAR: The industry is already about at the appropriate level. Installation of event recorders on a little over one-third of the road locomotive fleet of Class I carriers is enough to accomplish meaningful application to those runs that can benefit-- mainline train movements. Many of the operations of regional and short line carriers as well as Class I carriers are confined to either "switching" tasks or involve limited transfer hauls for which the use of event recorders would yield minimal returns and could not be justified.

FRA: If FRA proposes regulations, should they distinguish among the five Classes of carriers described in the first question? Why or why not?

AAR: Given the commendable record of the industry in installing and utilizing event recorders, governmental regulations are not needed. All past distinctions in adoption of event recorders have been based on installation in those particular service environments wherein actual benefits can be realized. That should continue to be the case. Obviously, mainline train movements are the best candidates. There is no justification for promulgation of regulations; and most of all there is no basis for indiscriminately

broad application by arbitrary classes of carriers.

FRA: Describe the generic types of devices in use today and the estimated percentage of the fleet installed with each type?

AAR: Most devices in common use produce similar outputs. There are two basic types. The first type records fundamental information for accident investigation purposes-- speed, time elapsed and distance traveled. The second is capable of recording a variety of multi-events. Typically, these recorders augment speed, time and distance details with other events dealing with aspects of traction motor current, automatic braking, throttle use, dynamic braking, direction of travel, and locomotive braking. Optional indicators often included are records of wheel slip, bell or horn (whistle)activation, and cab signaling. The supplemental data secured, beyond the basic three events, is compiled by individual railroad managements to enable selective analyses aimed at achieving greater operating efficiencies in particular areas.

Of the estimated 10,000 recorders now on-board locomotives, roughly 10% are of the three-event type.

FRA: Describe the "state-of-the-art" i.e., the capability of devices available on the market today?

AAR: Most recorders now being ordered provide for continuous multi-event recording on a magnetic tape cartridge. In the majority of devices, the most recent 48 hours of information is retained with the oldest data being automatically erased. When removed, these tapes can be transcribed to selected paper chart forms by a portable or a more permanent desk top playback unit. The latter may be coupled to a computer and printer to allow summary of various programs which generate "exception" reports.

On the whole, the recorder devices on the market are reliable and have more than sufficient capabilities for accident investigation purposes. It should be noted that the features now offered exceed what is required in normal accident investigations where, for example, a continuous 8 hour tape capacity with three events recorded would be acceptable.

FRA: Should FRA mandate standards for the construction and maintenance of event recording devices?

AAR: From any reasonable persepctive, there are no grounds for FRA to mandate standards for the construction and maintenance of event recording devices. Despite the fact that recordings play only an indirect role in promoting safety, the industry has implemented wide spread use of dependable event recording devices without Federal intervention. The performance of the units in service has been extremely dependable and we know of no case where the data has been lost due to damage in accident scenarios. Further, enhancements have been developed, tested and adopted through marketplace interactions at a rate which would only be depressed or stifled by institution of Federally mandated design standards.

There are indications that affordable performance monitoring is in the offing. For example, we believe that it may be practically feasible to install a continuous indicator light to confirm to crews that the cassette is in place, power is being supplied, and speed pulses are being received.

The advantages of a simple performance oriented kind of monitoring system such as this completely obviates any gains that might be perceived from imposition of rigid construction/maintenance specifications. On the contrary, from history we know that set-in-stone mandates invariably carry bureaucratic baggage that retard the rate of supplier innovation and thus the progress of upgrades.

FRA: Are there uses for event recorder data beyond its traditional funciton in accident investigations? If so, what are those uses? Were "management benefits" (for example, the ability to measure locomotive and/or crew performance over varying terrain or with trailing tonnage of varying amounts) part of the decision to install event recorders on a carrier's fleet? How were the costs and benefits of those uses evaluated before the installation decision was made? Has experience changed those original projections? How?

AAR: Management by definition constantly re-evaluates policies and procedures. Based on information that measures affectiveness, resources are allocated according to expected benefit priorities. The answer as to what particular data should be gathered is locked into approaches to gain competitive advantages. Thus, it is no surprise that individual railroads to various degrees have found that accumulation of actual operating data on the performance of crews and locomotives is valuable in deciding how incremental improvements in efficiency can best be reached. There are many ways to do this, one of which is through installation of additional sensors on locomotives which provide inputs that are recorded on-board. Several data acquisition methodologies compete for resources in this respect-- including those located on-board, at trackside, and those obtained through special studies, sampling observations, periodic audits and quite often through the conduct of instrumented tests. Those portions of railroads with the most challenging combination of terrain and train consists usually are high cost areas and thus deserve (and receive) most attention. Based on evaluations of potential improvement opportunities, on projected costs of several alternatives and on expected benefits, management decisions are made.

The choice of the means to prioritize "mnagement betterments" should be a prerogative of each railroad's management and not dictated from the outside.

FRA: Are all classes and types of locomotives compatible with event recorders? If not, why not?

AAR: From a purely technological viewpoint, it is possible to outfit almost any locomotive (or any vehicle for that matter) with event recorder devices. However, as argued before, that is not to say that it should be done on all types of locomotives or that the extent of modifications and costs are the same.

FRA: Are distinctions between the types of data that should be recorded in passenger and

freight operations?

AAR: It is evident from prior installations, that railroads are utilizing recorders on mainline trains whether they carry passengers or freight. The basic recording of speed, time and distance provides the essentials for accident investigation in either case.

FRA: What events should be recorded:
-- For accident investigation purposes?
-- For purposes other than accident investigations?

AAR: The essential event information needed for accident investigation purposes is train speed, time elapsed and distance traveled. Often these can be derived or enhanced from other sources than on-board recordings.

The desirability of inclusion and/or addition of supplemental measurements is dependent upon individual carrier evaluations of the best ways to determine efficiency improvement opportunities in regard to crew and locomotive performance.

FRA: What technological advances can be reasonably anticipated in event recorders over the next five years?

AAR: It appears that near-term technological advances will be aimed at incorporating solid-state storage mediums as a direct replacement of the current magnetic tape cartridge unit. Within several years, it is anticipated that on-board computer systems (such as proposed in the Advanced Train Control System or Advanced Railroad Electronic System projects) will efficiently accommodate an accumulation of a flexible array of event data which can be combined to produce other beneficial functions-- such as effective, non-intrusive "alerting" of the locomotive engineer.

It is important that FRA take no action in the interim which will preclude advances or create obstacles to achievement of forecasted more rewarding locomotive improvement potentials/goals now in project plans.

FRA: Are all "hot box" detector readings currently being recorded? How? Why/ why not? Where are the recordings made? Where are the recordings maintained? How long are they maintained? How are train crews informed of the reading of a hot box detector? Are they informed of both negative and positive readings? Are recordings made and maintained of the notification to train crews of positive hot box indications?

AAR: No hot box detector measurements are currently transmitted from wayside to the locomotive and simultaneously recorded or displayed on-board.

As of this time, wayside detector information may be used to trigger trackside indications visible to the train crew. With the extensive use of caboose-less trains, railroads are in the middle of an extensive program to equip wayside hotbox detectors with "talkers" i.e., wayside base radio stations that with micro-processor units send a voice message to the train crew which is heard in the locomotive. Both negative ("no hot box found") or positive messages("hot box on 33rd axle, north rail or north side of train")are transmitted.

Also several railroads have the hot box detector readout sent to a central location, such as dispatcher's office where either a person reads the tape or the data is fed into a computer which provides analysis for the dispatcher who then informs the train crew via radio communications.

Short of installing on-board computer systems, including development of wayside/ locomotive data transmission links (similar to that proposed in advanced phases of ATCS project), it is not feasible to record hot box readings in the locomotive under existing state-of-the-art conditions. Furthermore, the cost of doing this for most mainline trains within the next two or three years is prohibitive. Diversion of resources for this purpose would be counterproductive to the attainment of the goals of more encompassing, more attractive and much higher priority locomotive improvement projects.

FRA: Is there an advantage to requiring compatibility among event recorders? Should, for instance, all required devices accept a standard cable connector? Is there a standard pick up transducer signal that all devices could or should accept? Is the issue of campatibility or standardization a valid subject for Federal regulatory involvement?

AAR: Achievement of bottom line operational compatibility must be the aim of any proposed set of requirements. From the results to date, it is evident that necessary compatibility has been achieved by normal industry workings without Federal regulatory involvement. Manufacturers and suppliers of the equipment are well informed of compatibility demands and have produced components (including transducers) which acceptably interface with all variations of road locomotive configurations. Most noteworthy, innovative development of affordable event recorder capabilities on the part of manufacturers is readily evident.

Given the extensive accomplishments demonstrated, Federal actions to dictate "nuts and bolts" compatibility requirements would be misplaced and would only deter further progress. The record shows that no need for a regulatory Federal role in standardization exists.

FRA: What design or installation factors could make current devices more resistant to tampering? What action, if any, are manufacturers taking to incorporate such changes in future designs?

AAR: Most often, the existing recorder unit and other modules have been purposely located in a relatively hard to reach and inconspicuous location in the "air" compartment under the cab floor. Both the recorder and magnetic recording tape are housed in a rugged steel enclosure; and the front cover access to the tape cartridge may be locked and/or sealed.

Considering that the event recorder does not in itself directly contribute to the added safety of any specific train trip (it only records what happened after-the-fact), employment of the precautions now available provides adequate resistance to tampering.

Ultimately, future systems will provide the optimal answer. Conceivably, they should

be able to periodically or on command "dump" data to a remote central location.

FRA: Where and how should event recorders be mounted to both increase their chance of surviving an accident and yet ensure that they remain accessible for maintenance and inspection?

AAR: The predominant location of the recorder components on equipped locomotives is in the "air" compartment close to the center sill. Unlike earlier "paper" tape chart versions, the magnetic tape data packs do not require daily maintenance. Each cartridge can be operated continuously for over 6 months. In actual experience, data on the tapes has been retrievable despite involvement in catastrophic accidents involving fires; and incursions of water, fuel and oil have not seriously damaged the tapes.

Normal maintenance and inspection tasks are performed by accessing through the panels on the locomotive exterior. We see no reason to alter either this preferred location or the mounting methods now employed.

FRA: How are current devices inspected and maintained? How often are those inspections made? How often should inspections be performed? What calibration procedures are performed and at what frequency?

AAR: Although there is every indication that event recorder components need not be visually inspected for at least 6 months, it is common practice to conduct tests of the units when the locomotive is receiving Mechanical Department attention, i.e., on a 92-day cycle. Both portable and stationary playback and test equipment are procured from manufacturers and used at 92-day intervals to verify the faithful operability of the equipment. Either simulated or actual sensor inputs can be utilized during these "checks".

The accuracy of output has been good-- well within the bounds of need. There are reasons for this. Direct "raw" values are always recorded. Necessary calibrations that comprehend, for instance, wheel size (used in distance and speed determinations) can be introduced (as may be confirmed after-the-fact) during playback. Time indicators are generated by high quality accurate "crystals".

In summary, a 92-day maintenance interval is more than sufficient.

FRA: What indications do (can) these devices give to inform train crews that they are on and functioning? Is there a way that these devices can alert a crew if they cease recording events during a movement? Are such features incorporated in any currently available devices?

AAR: Based on their indirect after-the-fact contributions to safety, it is neither crucial or imperative that every mainline train have every data channel being recorded for 100% of the time for 100% of all movements. The mere presence of an event recorder on a train may influence crew actions, but does not in itself make the trip safer. Nevertheless, we know from past performance that this equipment could virtually run without attention for 6 months. If the crew has confirmation that there is a working system at train departure, there is an extremely high likelihood that the device will continue recording, without malfunction, well beyond train tie up.

We are led to believe that it is possible with some additional wiring to provide a "monitoring" light in the cab which will remain in a steady lighted state whenever the cassette is in place, the unit has power and speed pulses are being generated. Failure of any of these could be signaled by a "blinking" condition of the light which would serve to alert the crew that the unit may need to receive attention at the next initial terminal point.

Having said this, once again, the purpose and limitations of recording key events during a train trip must be stressed. Basic information is produced on operating history which, when complied, can be valuable in later analysis for many reasons. The Federal government should not view acquisition of this type of data in a way which will force incurrence of intolerable high costs due to a mistaken belief that no train should be allowed to move unless it has been established with complete certainty that every bit of data is being accurately recorded. Such a position would be foolhardy and completely unwarranted from any legitimate safety interest perspective.

FRA: What standards for accuracy, if any, currently prevail among recorder manufacturers? What calibration procedures are necessary to maintain that accuracy? If FRA proposes regulations, should they include standards for accuracy? If so, how should those standards be developed?

AAR: We have found that the event recorders being used today meet ideal design objectives. They maintain accurate records but do not require adjustments or calibrations on-board. In fact, there is nothing to adjust on this equipment. The basic measurement of time is crystal generated; and distance traveled is based on continuous "counting" of wheel revolutions. The wheel diameter can be verified and adjusted to suit verified dimensions during play back.

In actual practice, time after time these records have been found to be true. Usually there are known external conditions that can be retrieved to serve as backups to isolate a particular point in time or a sequence of train movement events. Speed derivations are well within existing specification of $\pm$3 mph. There have been no problems in the accuracy of resultant data when utilized in past accident investigations.

FRA need not go beyond the existing published specifications which already govern the accuracy of devices such as speed indicators.

FRA: What is the installed cost of currently available devices, broken down for materials and labor?

AAR: The reported cost of inclusion on new locomotives is relatively low. Otherwise, it is understood that, in addition to the price of the equipment itself, between 8-16 manhours are required for installation at the locomotive site. Of course, there are other locomotive movement and overhead burdens.

Totals costs are dependent on many other factors such as the number and type of sensors a railroad elects to invest in.

FRA: What maintenance costs do these devices require on an annual basis? Are these costs related to the number and type of events that a device may be required to record?

AAR: Since AAR is not privy to extensive failure analysis facts that are unique to specific carriers, we cannot estimate overall average annual maintenance costs. Certainly both the procurement and maintenance costs go up as the number of events recorded are increased or additional, more complicated, sensors are added. We know that playback costs now vary significantly depending on the frequency that individual railroads review tapes and how often intensive analyses are conducted.

FRA: Will anticipated technological developments materially alter the response to the two preceding questions?

AAR: As FRA recognizes, the industry has embarked on an ambitious project to consolidate technological advances into a comprehensive train management and control system. To the extent that train related data can be generated as an integrated bi-product of the "real-time" operations of trains, such data will be more accurate, more pertinent, more tamper resistant, more reliable and more timely. Most of all, the "sharing" of costs among functions will yield important savings. More importantly, the independent establishment of new requirements for present "stand alone" functions (such as event recording) at this time could be disruptive and drain available resources away from efforts to implement more effective technological consolidations.

Yes, technological developments now underway should significantly reduce the incremental costs of event recording (and be much more effective) if these are allowed to continue without undue hindrance.

FRA: If FRA does propose regulations, should they be limited to newly purchased locomotives? Comment generally on the costs and benefits of a rule that would go beyond requiring event recorders in newly manufactured locomotives to include a mandatory retrofit of the current fleet.

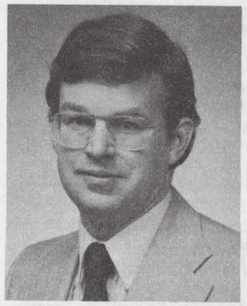
AAR: Given that railroads are already ordering state-of-the-art event recording equipment on new locomotives, that they are routinely utilizing reliable even recorders on mainline road locomotives, and that the vast majority of eligible train movements are now covered, there is no need for a Federal mandate for either new or existing locomotives.

FRA's afety mission is best served by acknowledging the continuing "safety" contributions of existing capabilities and leaving it to the rail industry to complete its well founded efforts to harness emerging technological advances into an effective on-board/communicative network that will produce significantly more enhancements than would several splintered and premature "stand alone" forays.

We believe that the results of this inquiry will substantiate that the rail industry is on the right course of action. It is entirely wrong to interject "chilling" governmental regulations into this successful industry initiative.

As with all government regulations, FRA if it does issue requlations, such regulations will have to be sent to the Office of Management & Budget for approval before they would become operative. Record keeping, if required, would be subject to application of the Paper Work Reduction Act of 1980, which is given a close scrutiny by OMB.

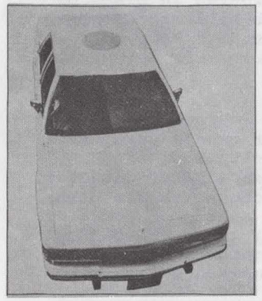
Vehicular Electronics

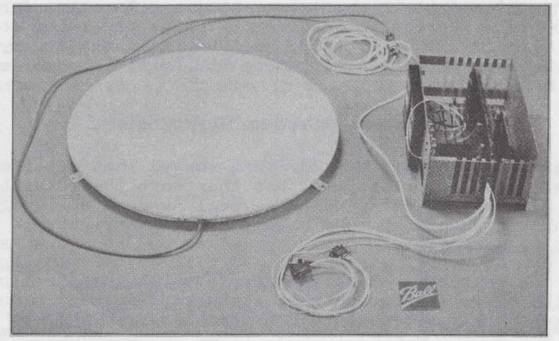


Bill Fleming
Vehicular Electronics Editor

Mobile/Satellite Communications Advances

Cellular mobile telephone systems work well in urban areas, but mobile-satellite systems are needed for use in low-density rural areas [7,8]. CONUS (CONtinental United States) mobile telephone coverage is forthcoming. Ball Communications has developed and demonstrated electronically steered tracking, transmit/receive antennas for mobile application [8]. The antennas operate at L-band frequencies -- near 1650 MHz for signal transmission, and near 1550 MHz for signal reception. The phased-array mobile antenna is shaped like a flat circular plate and is mounted atop the vehicle roof. The antenna locks onto and tracks geosychronous satellites from anywhere in the continental United States. Closed-loop dither-tracking methods are used to find the satellite, whereas open-loop gyro-tracking methods are used to maintain pointing during short signal outages (10 s or less). In volume production, cost is projected at $1,620 per antenna.





Electronically controlled phased-array antenna for mobile satellite-telephone use

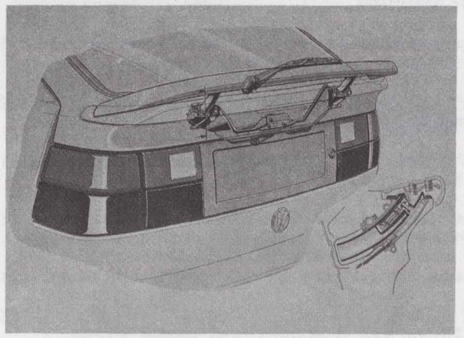
1989 Automotive Electronics Developments

For 1989, Cadillac De Villes and Fleetwoods offer the ElectroClear system, designed to clear frost or ice from the windshield 3 to 5 times faster than conventional defrosters [10,11]. With no difference in appearance from conventional windshields, the ElectroClear windshield includes a transparent, vacuum-sputtered, multi-layer, conductive silver-based film embedded in the glass. A special 3-phase ac alternator, together with a voltage step-up transformer, provides 75 Vdc power to the ElectroClear system. This voltage is supplied to the windshield via a split path of -34 Vdc and +41 Vdc, therein minimizing shock hazards. Other safety operating restrictions are built into the control module/body computer to avoid potentially dangerous use of the system [11].

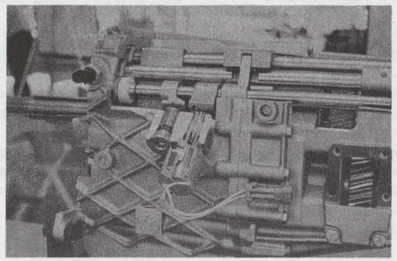
Remote keyless entry is standard on Buick's 1989 Reatta [11]. A small, hand-held transmitter doubles as a keytag, and communicates via coded radio-frequency signals with a receiver/controller module in the car. With this device, an owner can lock or unlock the car's doors or trunk remotely from as far as 9 meters away. In addition, selection of any unlock function activates the illuminated entry light group. And the theft-deterrent system is also armed or disarmed at the same time that the doors are locked or unlocked.

The new Corrado Volkswagen includes an automatically extending and retracting rear spoiler [12]. For West German Autobahnen use, the spoiler extends 50 mm at speeds above 120 km/h and retracts at city speeds. The extender is needed because, when stationary, an extended spoiler might not conform to safety standards regarding pedestrians. At Autobahnen speeds, rear axle lift is said to be reduced 64 % when the spoiler is extended.

The 1989 ZR1 Corvette with the LT5 engine option includes double overhead cams, four valves per cylinder, and a ZF 6-speed gearbox [11,13]. Apparently, this powertrain is so awesome that to permit compliance with fuel economy requirements (to avoid a "gas guzzler" tax), a solenoid-activated override is included to prevent the driver from shifting through all available gears. The solenoid drives a pin into a cam plate on the transmission guide rail, thereby forcing the driver to make direct upshifts from first to fourth gear. This shift inhibiting action is only activated under low-load driving conditions -- between 12 and 19 mph, with throttle less than 35 % open, and coolant temperature above 120 °F.



Volkswagon automatic-extending spoiler



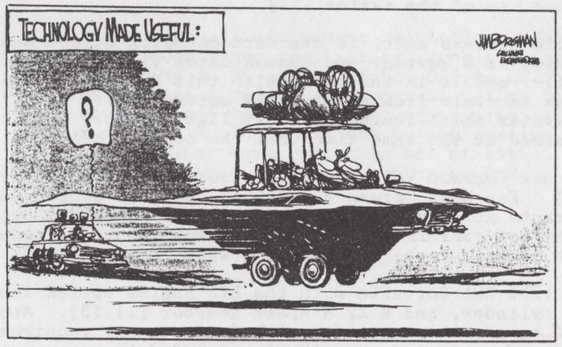
Corvette upshift-preventer mechanism

In a related development, use of high-performance memory chips and other computer changes to boost horsepower may be all but eliminated by regulations about to be enacted in California [14]. It is estimated that as many as 10,000 engine-performance-enhancing chips, which take just minutes to install, have found their way into vehicles. To stop micro-chip swappers, the California Air Resources Board will require that memory chips be either soldered in place or potted in place, starting with 1992 models. And, by 1995, engine computers will have to be designed to keep "hot-rod hackers" from reprogramming ECC built-in memories.

Vehicular Speed Detection/Stealth/Safety?

Radar detector manufacturers commissioned a study that showed that detector owners were involved in fewer accidents than other motorists and that they wore their seatbelts more often (they better do so) [1]. However, after spending several hundred dollars on a radar detector, owners will probably be unhappy when they find police using laser guns to check vehicle highway speeds. A laser speed gun, similar to conventional radar guns, checks speeds of targeted cars without alerting the driver [1-3]. Another disturbing development for radar detector owners, if they own a new car featuring "heads up display," is that the speedometer display can be read from outside the car. This means that highway policemen in unmarked patrol cars are now able to directly read their speed while driving alongside [4].

Where is all this heading to? How about Northrop's spin-off of a stealth mini van, based on their stealth fighter aircraft technology [5]. The stealth mini van, shown below, would be totally invisible to radar and laser detection. Pricing of the van has not yet been disclosed. Then there's an IEEE proposal involving electronic "tag bullets" [6]. Drivers could purchase radio guns that shoot narrowly directed millimeter-wave, coded pulses. Upon license renewal drivers are given, say, a dozen expendable bullets. All cars would have embedded receivers that tally "hits." When the number of hits reaches a legally determined figure, that driver's license would be suspended, or perhaps the car itself would be automatically disabled for a period of time. Imagine. How satisfying it would be to pull out your radio gun and tag (zap) offending, discourteous, and unsafe drivers before they get away [6].



Northrop introduces the Stealth Mini-van

New laser speed gun may be unable to detect stealth mini van

Enter the Age of Intelligent Materials

Recently, I attended a MIT Symposium on intelligent components, or more specifically, on intelligent materials [9]. Here are some concepts presented at this symposium.

- There's a new breed of students called "translators," who grew up with computers and now want to put them into everything, including structures and materials.

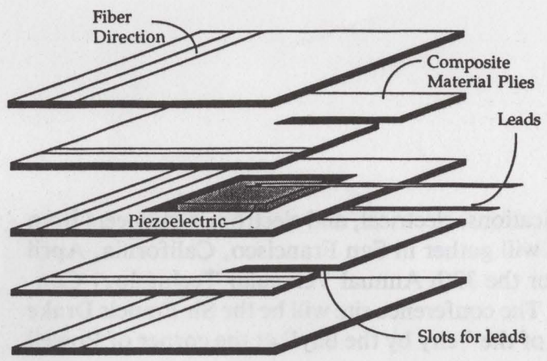
- For the first time, availability of advanced composite materials permits engineers to design materials of choice, instead of having to work with the properties of available materials.

- Intelligent "smart skin" materials can potentially be designed to provide acoustic stealth (for submarines), thermal and color stealth (for aircraft); via local, distributed sensor/actuator/control systems embedded in custom-designed composite materials. Although currently driven by military customers, "smart skin" materials have obvious automotive applications for noise abatement and comfort control.

- As shown below, adaptive trim control of airfoil surfaces was demonstrated using piezo-bender actuators embedded in composite material.

- For engine vibration control, electrically loaded piezoelectric engine mounts were described. Changes in the tuning characteristics of external electrical loads shifted the absorbing characteristic curve as a function of, for example, engine speed. No input voltage is required -- the engine mounts are passive, electrically tuned, load-dissipation devices.

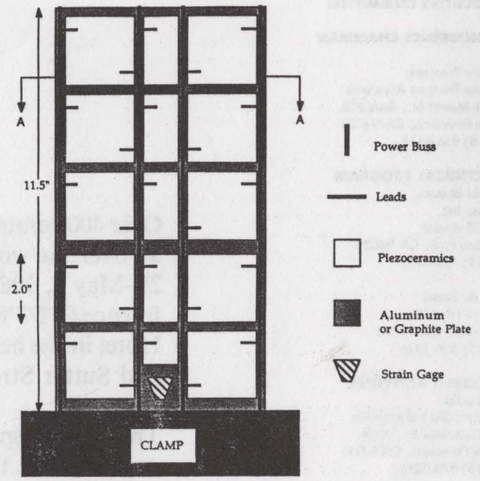
- In general, intelligent materials are best suited for control of distributed, high-frequency, narrowband disturbances. On the other hand; large-scale, low-frequency, broadband, structural disturbances are still the domain of conventional global controllers.



Hole and slots for piezoelectric and leads are cut out of composite plies.

Thickness of laminate remains approximately constant.

Piezo-Bender "smart skin" composite material fabrication



Anisotropic "smart skin" composite airfoil provides bending, extension, and twist

References

1. C. Jensen, "Detection and Prevention," AutoWeek, December 12, 1988, pp. 20-22.

2. C. Vogt Jr., "Radar Detectors May Become Obsolete," Design News, November 7, 1988, p. 16.

3. D. Bell, "State Police To Test Laser Gun Immune To Fuzzbuster Detection," Detroit Free Press, December 18, 1988, p. 10A.

4. "Ain't Technology Grand?," AutoWeek, October 31, 1988, p. 12.

5. J. Borsman, "Northrop Introduces the Stealth Mini Van," Detroit Free Press, December 16, 1988.

6. R. Lucky, "CarWars," IEEE Spectrum, November 1988, p. 8.

7. W. Rafferty and K. Dessouky, "RF Development for Mobile-Satellite Systems," Microwave Systems News, November 1988, pp. 28-37.

8. F. Schmidt and B. Cox, "Electronically Steered Phased-Array Antenna for MSAT," Microwave Systems News, November 1988, pp. 41-47.

9. A. Epstein, "Intelligent Components In Aerospace," MIT Industrial Liaison Program, Massachusetts Institute of Technology, Cambridge, MA, November 15, 1988.

10. R. Jurgen, "New Frontiers for Detroit's Big Three," IEEE Spectrum, October 1988, pp. 32-34.

11. A. Demmler Jr. et al., "1989 Technical Highlights of Big-Three U.S. Manufacturers," Automotive Engineering, October 1988, pp. 63-93.

12. S. Birch, "VW's Corrado," Automotive Engineering, November 1988, pp. 79-80.

13. C. Murray, "Computer Directs Manual Transmission," Design News, October 3, 1988, p. 246.

14. "Stopping the Swapping of High-Performance Chips," AutoWeek, December 12, 1988, p. 11.

GATEWAY TO NEW CONCEPTS IN VEHICULAR TECHNOLOGY
39th IEEE VEHICULAR TECHNOLOGY CONFERENCE

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NEWS FOR IMMEDIATE RELEASE

IEEE TELECOMMUNICATIONS CONFERENCE IN SAN FRANCISCO

Over 400 communications, electrical, and electronics engineers from all over the world will gather in San Francisco, California, April 29–May 3, 1989 for the 39th Annual Vehicular Technology Conference (VTC'89). The conference site will be the Sir Francis Drake Hotel in the heart of the "city by the bay" at the corner of Powell and Sutter Streets.

This event is sponsored by the world's largest technical professional organization, the Institute of Electrical and Electronics Engineers, Inc. (IEEE).

The theme of this year's conference is **"Gateway To New Concepts in Vehicular Technology."** This theme will be demonstrated by the delivery of about 150 technical papers on subjects ranging from "Cellular Systems Technology" to "Vehicular Electronics" and titles ranging from "Multi-Site Throughput of a Mobile Digital Radio Link" to "Electronic Rails on American Highways." The authors are from fourteen countries throughout Europe, Asia, the Middle East, Scandinavia, Australia, and North and South American and represent some of the world's largest and most technologically advanced companies and institutions of learning.

Dr. Thomas Stanley, Chief Engineer of The Federal Communications Commission, will be the featured speaker at the luncheon on the first day of the conference.

Advance Conference Programs will be available in March, 1989. For registration information please call Ivy Magsaysay at 415-956-6118.

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