Semiannual Report No. 2
Covering the Period July 1 to December 31, 1971

TRANSFER OF AEROSPACE TECHNOLOGY TO SELECTED PUBLIC SECTOR AREAS OF CONCERN

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
TECHNOLOGY UTILIZATION OFFICE
NASA HEADQUARTERS
WASHINGTON, D.C. 20546

Attention: MR. ROYAL G. BIVINS, JR.
CODE KT

CONTRACT NASw-1992

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By: JOSEPH G. BERKE

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SRI Project PYU-8368

Approved by:

CHARLES J. COOK, *Executive Director*
Physical Sciences Division

PREFACE

The NASA Technology Applications Team at Stanford Research Institute has been active in the technology transfer program since July 1, 1969 under Contract NASw-1992. This report is the second in the continuing series of semiannual reports and covers activities in the fields of criminalistics and transportation. The overall objectives of the program are to transfer aerospace technology for the solution of important technological problems in the two public sector areas and to implement and continuously refine appropriate methodologies and mechanisms to ensure successful transfers and provide appropriate visibility for program activities.

The members of the core Team at SRI are

Charles J. Cook, Ph.D., Program Supervisor and Executive Director, SRI Physical Sciences Division

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ILLUSTRATIONS

I ACCOMPLISHMENTS FOR THE PERIOD

A. Complex Coordinator (C-13)

At the time of our last report in July 1971,[1] a prototype of the Langley Complex Coordinator, a device for measuring human coordination and reaction time, had been demonstrated successfully to the California Driver Education Association and the Citrus Belt Driver Education Association. Education departments, law enforcement agencies, and hospitals expressed interest in obtaining these devices for testing, educational, and rehabilitation purposes.

The Small Business Administration in Philadelphia located a minority-owned small business with the ability and desire to manufacture the Coordinator. NASA Headquarters and Langley Research Center have supplied technical assistance to this company. The SRI/TATeam has been working with the company to establish markets for the product among its user agencies and to determine desirable product design characteristics. A basic design of the device is expected to be on the market during the first half of 1972.

B. Correlation of Toolmarks by Microtopological Analysis of Striae (C-20)

Toolmarks are one of the most commonly occurring items of physical evidence at the scene of a crime. In the 16,000 homicides, the 350,000 robberies, the 2,200,000 burglaries, and the 330,000 assaults occurring annually in the United States, more than 1,000,000 tools* are used. There are three major categories of toolmarks: jimmy marks, gun barrel marks, and marks left by the jaws of a cutting instrument. The technique for analysis of the marks is the same in all of these cases, and it can provide a connection between a crime and a specific tool, e.g., a murder bullet and a pistol band, or a burglarized file and a screwdriver.

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* Tools used in bicycle and automobile thefts are not included; these data would increase the number greatly.

In the late 1800s, it was found that low incident light over a cut surface produced a series of dark and light lines that could be photographed. If two objects were cut with the same tool, then the series of lines called striae would be nearly identical in the two photographs. However, even with the comparison microscope, which allows two marks to be placed in juxtaposition, the process is time consuming because each mark must be directly compared with every other mark. The final decision as to whether or not two marks were made by the same tool is made by the examiner, using a process that is mainly subjective.

The surface profilometer developed at Argonne National Laboratory (Tech Brief 69-10345) appears to offer the basic tool needed for a major breakthrough in toolmark analysis. The profilometer, or a modification thereof, would translate the surface features into electronic signals. Then by means of signal-averaging techniques or mathematical transformations, such as derivative analysis of these signals, meaningful data could be presented to a computer system (Figure 1). A visual display chart recording could be made at any point in the analysis system. With this

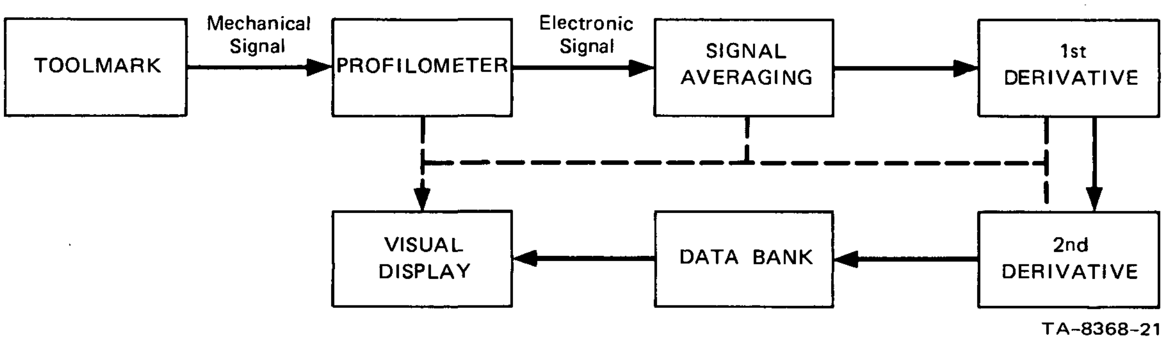

FIGURE 1 TOOLMARK ANALYSIS SYSTEM

procedure, the original analysis could be made by a technician. A permanent record of the toolmark would be kept in the data file. A data bank would be established for toolmark comparisons. From this, mathematical criteria could be established as to what constitutes a "match." A feasibility study is needed to obtain the necessary systems, join the profilometer to the computer, optimize the signal analysis, build the data bank, and test the recall abilities.

C. Simple Method for Analysis of Metals and Metal Products (C-22)

Crime laboratories need a systematic, simple, nondestructive technique for rapidly identifying a variety of metals from different sources. NASA's Langley Research Center has a chemical system, "Nondestructive Rapid Identification of Metals and Alloys by Spot Tests" (TSP 70-10520), that affects only the amount of material equivalent to the stroke of a smooth file or cleaning with an abrasive cloth. Conclusions relative to identification are derived from unique reactions or from colors produced by the addition of reagents. This problem and the proposed NASA solution were discussed in an earlier report.[1]

As part of an investigation into the cause of a series of helicopter crashes recently in Anchorage, the Alaska Medical Laboratories successfully used the chemical spot test to differentiate between the alloys of helicopter blades. The New York Police Department's crime laboratory used the NASA method in four cases involving firearms. Before the obliterated serial numbers could be etched out, the metal alloy had to be known in order to choose the most effective etching solution. By using the reagents of the spot test, laboratory personnel were able to identify the alloys.

Many other crime laboratories indicated a desire to try this system. However, assembling a set of metal standards for making comparisons would be difficult and expensive. The SRI TATeam wished to make sets available to the approximately 100 criminalistic laboratories as a tool for quick apprehension of perpetrators of crime. With the help of the Small Business Administration, the Team located a small company that is planning to prepare and market kits containing about 75 metal standards. These kits should be available for distribution to crime laboratories in mid-1972.

D. Photographic Methods for Surface Characteristics (C-25)

The photographic documentation of surface characteristics is a difficult procedure because light reflections or a lack of contrast, or both, can obscure the details. Moreover, many of the surface characteristics, such as restored serial numbers or faint tool impressions, are small. To complicate the procedure further, the necessary magnification results in a shallow depth of field.

Polarized light photography, used in identifying fatigue zones in metal (TB67-10082, "Fatigue Zones in Metals Identified by Polarized Light Photography"), appears to be a basis for a solution to this problem. This simple photographic method detects small imperfections in the surface of an object, imperfections which are the basis of comparison for the criminalist. Several crime laboratories are currently conducting feasibility tests of the method.

The crime laboratory at the Contra Costa County Sheriff's Office wishes to adopt this technique. A problem currently exists with their polarizers, but they have just obtained a device for measuring the degree of polarization and will try this NASA procedure in the near future.

E. Educational Methods in Analysis (C-26)

Approaches to the analysis of an unknown are critical elements in the education of a forensic scientist. The need is expressed for methods designed to enhance the orientation of a scientist to, or to guide the development of a student in, the selection of retrieval schemes for the informational contents from an object of evidence.

In addition to the SRI/TAT Newsletters which contain a variety of problems and possible solutions, the conceptual approach expressed in Tech Brief 68-10373, "The Use of Product Identification as a Training Aid for Analytical Chemists," has been utilized by several academic institutions in formulating course materials. Both Sacramento State College and the University of Illinois in Chicago have incorporated this NASA-generated information into their programs.

The dissemination of Newsletters will continue as a means of informing laboratories of current technology having criminalistic applications.

F. Enhanced Discrimination of Photographic Negatives (C-29)

Crime scenes, whole or in part, are photographed routinely in investigations. The black-and-white negatives contain much information that is not exploited because of the limitations of human visual perception. The range of gray tones available is not sufficient to delineate all the minutia comprising the physical evidence.

The luminescent screen apparatus was developed at NASA Headquarters (TB 70-10440, "Luminescent Screen Composition and Apparatus"). Because of the screen composition, which includes a mixture of many phosphors, a photographically produced image can be projected by ultraviolet light. Polychromatic images (pseudocolor) make use of the human discriminatory power for hues. Approximately ten brightness levels can be differentiated over the brightness range available with a monochromatic transparency. However, when viewing a polychromatic image, it is possible for an observer to discriminate about 200 separate hues at a constant brightness level.

Samples of the screen will be distributed to a number of criminalistic, radiological, and photographic laboratories for evaluation of commercial potential.

G. Obliterated Serial Number Restoration (C-30)

Before the police can trace ownership of an object having an obliterated serial number, the criminalistic laboratory must restore the number. Normal restoration processes (acid etching, electroetching, and catalytic reactions) are not always successful, however.

Ultrasonic etching of metal has been accomplished at NASA's Lewis Research Center ("Ultrasonic Metal Etching for Metallographic Analysis," TB 71-10099). A magnetostrictive transducer was used to generate ultrasonic vibrations which were transmitted to a layer of distilled water between the transducer head and the metal specimen. The metal was etched by bubbles in the ultrasonically excited water. By using this method for preetching or by combining ultrasonic and chemical etching, an obliterated serial number may be revealed.

One crime laboratory tried using ultrasonics for etching. The equipment used was the bath type rather than the probe type, however, and restoration was minimal. Utilization by another laboratory is planned.

H. Inexpensive Light Table (C-34)

There is a need in the criminalistic laboratory as well as in the hospital for a portable, inexpensive light surface for examination of transparencies and reading of blood-grouping results. The surface must not generate heat since this would destroy or alter some of the samples.

The light table described in NASA SP-5919(01), "Flat Surface Converted to Light Table," fulfills the requirements for the criminalistic laboratory. A steel backing plate is coated with an electroluminescent material which is then covered with a transparent ceramic. Parallel plug blades, one contacting the electroluminescent material and the other contacting the plate, are attached to a conventional power cord.

Plans include obtaining models for evaluation of potential commercialization by several crime laboratories.

I. Collection of Arson Residue (C-35)

Flammable vapors at an arson scene are easily detected by a vapor detector. A sample of the vapor residue is then collected for laboratory analysis. With the increase in arson cases in the past few years, laboratories are inundated by bulky, dirty, charred residues. If a residue is not analyzed within a few days, the flammable vapors may be lost or become unidentifiable.

A vapor-concentrating device was designed for NASA's Ames Research Center by SRI under NASA Contract NAS2-4511. The airborne sampling system makes use of the ability of gas chromatographic column packing material to retain or trap organics selectively while permitting the permanent gases of the atmosphere to pass through the concentration trap.[2] Sufficient material can be isolated in the system to permit subsequent analysis.

Although this unit is too large for immediate use, a study is being made to design a portable device.

J. Profile Measurement of Pavement Surfaces (T-24)

Today's highways demand smooth surfaces that will provide safety and comfort at high speeds. Surface tolerances for new pavement construction are ordinarily given in terms of maximum allowable vertical deviation from a true plane in a given horizontal distance. A 1/8-inch deviation in 10 feet is a typical allowance. Concrete highways deteriorate from slab settlement, foundation movement, joint separation, cracking, and surface abrasion. A high-speed, accurate profile measuring device is needed to determine when surface tolerances are exceeded.

A suggestion was submitted by A. Silverstein of Naval Ordnance Laboratory wherein a road sensor is devised to detect the arc of curvature of the road along the line of motion. With this arrangement, the vehicle may oscillate vertically or pitch, but the reading at a given road position registers only the radius and polarity of the curvature.

The California Division of Highways has indicated interest in road testing this system. NOL will build a prototype when funds become available so that CDH can determine the feasibility of this technology.

K. Measurement of Residual Stress in Rails and Railcar Wheels (TR-39, 64)

The railroads are in need of a technique for nondestructively determining the stress condition of rails and railcar wheels. In recent years, rail spreading has been responsible for approximately 100 derailments annually in this country. Locked-in stresses, resulting from roadbed maintenance work done at different times and different temperatures, act in conjunction with lateral wheel loads to cause rail spread. These derailments, and the consequent expense and loss of life, could be significantly reduced if residual stresses in rails were monitored by maintenance or inspection crews. The measurement of residual stresses in rail car wheels is equally important in that broken wheels caused by changing circumferential stresses in wheel rims account for an additional hundred derailments each year.

The Astronautics Laboratory, Materials Division, at Marshall Space Flight Center (MSFC) has developed ultrasonic techniques that appear to meet the railroads' needs. These techniques are described in TB 67-10428 and SP-5082. Two Y-cut crystals are mounted with their axes of vibration at right angles. The crystals generate and receive signals, and a phase comparison reveals changes in ultrasonic velocity. The amount of phase shift between the two signals is then proportional to the average stress difference between the two directions of vibration, and the internal bulk stress condition of a metal can be determined.

The SRI/TAT has initiated an adaptive engineering program intended to show the feasibility of this technique for railway applications. NASA TUO is funding the work which is being conducted at MSFC. The objectives of the program are:

(1) To determine the ultrasonic velocity vs stress relationship for wheel and rail steels

(2) To investigate the effects of temperature on this relationship

(3) To evaluate measurement problems related to wheel and rail geometry

(4) To make laboratory stress measurements on wheel and rail segments

(5) To demonstrate the practicality of the technology with field stress measurements.

The AAR supplied the sample being used in this program. The results of the program will be available during the first half of 1972. Should additional applications engineering be required at that time, the Federal Railroad Administration has indicated a willingness to support the work. By the time the technique is shown to be feasible, portable test units, based on work done under NASA contract, should be available on the commercial market. It may be possible to modify this equipment to meet the railroads' needs.

L. Concrete Repair Material (T-53) and Concrete Sealant (T-57)

Highway departments need a strong, quick-setting, nontoxic material for repairing highways, especially bridge decks and approaches. The repair material must be easy to apply and quick setting to eliminate the need to close lanes during rush hours in heavy traffic areas. Currently, epoxies seem to be the only oil-resistant paving materials, and they are expensive. Another problem concerns corrosion of bridge decks. These decks have a projected life of 30 years; however, replacement has been necessary in five years because deicing chemicals seep through the concrete and corrode the steel.

A potential solution to both problems was found in Tech Brief 66-10453, "Thermoplastic Material Produced at Low Cost." This material was discussed by the SRI TATeam in an earlier report[1] as a potential road repair material. Jet Propulsion Laboratory developed the thermoplastic material under NASA Contract NAS7-100 as part of a program to find a better rocket propellant binder.

Several batches of the material have been prepared by SRI's Polymer Group. The first batch followed the JPL specifications, whereas subsequent batches varied the ingredients. Using the first batch, the Team patched holes in the SRI driveway (Figure 2). These patches are still intact after six months. Later batches were made containing waste products (crankcase oil, sulfur, and ground rubber from old tires) that are currently polluting the environment.

Samples of a batch containing crankcase oil were taken to the California Division of Highways for basic testing for ductility, adhesion, and strength. All tests were passed; however, the material had a 450°F melting point, too high for safe handling. Changes in the formulation were made that lowered the melting point to the recommended 250°F. Basic tests were again run by CDH with excellent results.

TA-8368-22a

FIGURE 2a MIXING AND APPLYING EXPERIMENTAL QUANTITIES OF THERMOPLASTIC MATERIAL

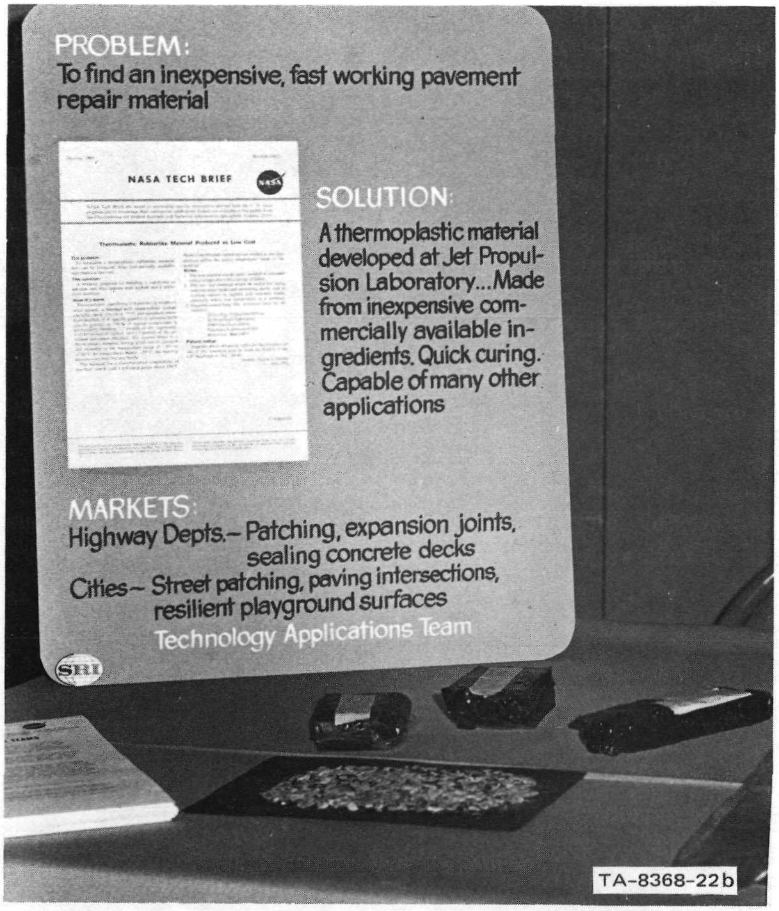

FIGURE 2b DISPLAY OF THERMOPLASTIC MATERIAL

Personnel at the California Division of Highways expressed particular interest in the thermoplastic material's resistance to automobile drippings which corrode idling areas, such as intersections.

M. Corrosion Protection for Steel Pilings (T-59)

Any bridge piling exposed to salt water is subject to rapid corrosion. Conventional construction practices require that the lower end of a piling be driven into mud and the upper end be encased in concrete. This practice, coupled with the salt water, causes galvanic corrosion of the transition zone--the piling section not encased in concrete and not sufficiently sealed by the mud.

The average rate of corrosion for a steel pile in such an environment is 0.005 inch per year per exposed surface. H-shaped pilings have two surfaces of each web exposed and therefore sustain a loss of 0.010 inch per year. Pilings are constructed from 5/8-inch thick steel. At the average rate of corrosion, half of the original metal will be gone in only thirty years, thus jeopardizing the safety of the bridge.

A potential solution to this problem was found in Tech Brief 70-10600, "Potassium Silicate Zinc Dust Coating," which originated at Goddard Space Flight Center. Metal plates, three each of 6061 T-6 aluminum and SAE 1020 cold rolled steel, were coated at Goddard with the potassium silicate zinc dust and given to the California Division of Highways for testing. A 3000-hour salt spray test is currently under way.

N. Improved Friction Material (TR-62)

The maintenance expense for postal vehicles and various government agency vehicles can be significantly reduced by the development of an economical friction material with improved wear characteristics for brake linings. In addition, the railroads desire a new friction material containing no asbestos, since asbestos particulate matter is believed to be a significant public health hazard.

The NASA-Ames Chemical Research Projects Office (CRPO) has been investigating improved friction materials for airplane applications. Some of the materials developed appear to be particularly suited to automobile use. CRPO personnel believe they can develop a friction material that will wear significantly better than commercial brake linings and will not contain asbestos.

The SRI TATeam has initiated an applications engineering program for this technology. NASA TUO has funded the Ames CRPO for a program to develop improved friction materials. This program will include

(1) Assessment of polyphenylene as an ingredient of automotive brake linings

(2) Development of a brake lining formulation containing standard ingredients and polyphenylene

(3) Investigation of the use of new materials for binders and substitutes for asbestos

(4) Development of a brake lining formulation having no asbestos.

Steps 1 and 2 should be completed by mid-1972. The Postal Service has indicated a willingness to perform full-scale vehicle tests with materials developed during Step 2.

O. Fire Protection of Rail Tank Cars (TR-63)

The Association of American Railroads (AAR) is now engaged in an extensive tank car safety study, one aspect of which requires finding materials to protect tank cars in postderailment fuel fires. A protective coating is needed to prevent the steel tank car shell from reaching a temperature of 800°F for a period of 1/2 hour to 4 hours. When there is a hazardous load, the damage radius of the fire that usually follows derailment can spread appreciably by the further rupturing of tank cars from severe heat loads.

The Chemical Research Projects Office at Ames Research Center has done extensive work in the development of materials for fire protection. A fiber-loaded intumescent coating having strength and weathering characteristics superior to commercially available coatings fulfills the requirements for tank car protection.

Samples of this intumescent coating were evaluated by the AAR/RPI (Railroad Progress Institute) Tank Car Safety Group, along with more than 40 other samples. The Ames material was one of seven meeting the time-temperature specifications and was the only coating meeting the specifications for ease of application, weatherability, and structural integrity. Its only shortcoming, a major one, is its high cost.

NASA TUO has supplied funds to the CRPO at Ames to undertake an applications engineering program intended to develop an improved low cost material specifically for this tank car application. When available, this material will be evaluated in the ongoing AAR testing program. The AAR is preparing a report on the allowable cost of coating systems with regard to the savings they can generate in reduced property damage. This report will provide a basis for screening proposed materials from an economic standpoint.

P. Railroad Tie Material (TR-66)

The railroads are interested in finding a material to replace wood in the fabrication of railroad ties. Wood will soon be in short supply. In addition, it has a shorter life than the roadbeds. The disposal of the 20 million creosoted wood ties requiring replacement annually is a major problem. Concrete has been considered as a replacement material, but it also is hard to dispose of and is not interchangeable with wood on current roadbeds. Because of new federal standards for track safety, tie replacement is expected to be accelerated over the next few years.

A switch to plastic foam ties, which do not suffer from the drawbacks of concrete, would have a great impact on this country's diminishing supply of wood. Also, the pollution problem associated with wood disposal would be eliminated since foam ties could be recycled as ties or for other uses. It is expected that conversion to foam ties would result in reduced maintenance expenses for railroads.

NASA's Ames Research Center, Chemical Research Projects Office, is developing high density plastic foams for aerospace applications. In cooperation with the SRI TAT, the Ames people are investigating the use of these foams for railroad ties. The work done thus far has been encouraging. One important characteristic is the foam's ability to anchor nails (Figure 3). As a result of this initial work, NASA TUO has funded an applications engineering program at the Ames CRPO having the following objectives:

(1) Formulate low cost basic polymer systems with inexpensive extenders, fillers, and reinforcing agents

(2) Develop key static and dynamic physical properties for candidate materials

(3) Screen samples based on physical properties and estimated costs for tie application

(4) Fabricate and test full-size ties in cooperation with the AAR

(5) Provide material, process, and application specifications for selected materials.

In addition to this work, the SRI TAT will investigate the trends in the supply and utilization of tie material for the purpose of providing reasonable economic constraints for the materials being developed by NASA-Ames.

Q. Vehicle Battery Check (T-73)

Because nickel cadmium batteries have no provisions for an adequate electrolyte reserve, each cell must be checked regularly to determine the electrolyte level. For agencies having large fleets of vehicles, these

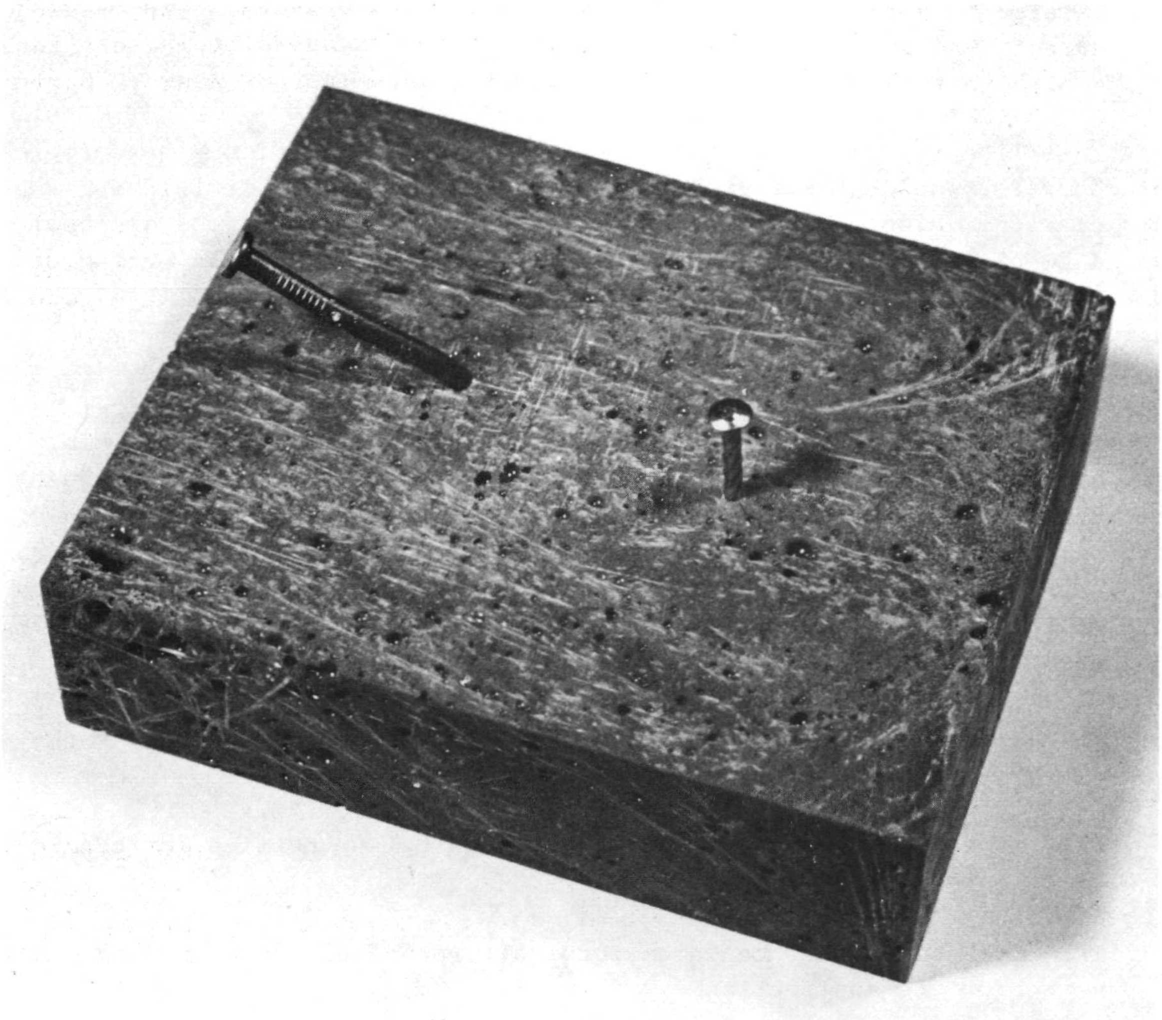

FIGURE 3 PLASTIC FOAM FOR RAILROAD TIES

battery checks require considerable time, most of which is spent unscrewing and rescrewing the battery caps.

Under NASA Contract NAS8-5608, The Boeing Company developed a transparent reserve electrolyte capacity cap that provides each battery cell with a combination electrolyte reserve and overflow chamber. In addition to making it possible to determine the electrolyte level without removing the battery caps, this device eliminates battery boilover which corrodes the battery connectors and nearby equipment. This innovation is described in SP-5928(01).

The International Association of Chiefs of Police, Inc. (IACP) expressed interest in this reserve electrolyte battery cap. The SRI TAT plans to solicit the interest of other government agencies in this technology and, if necessary, arrange for its manufacture by a small business.

R. Improved Foot Traction (PS-6)

Nonskid shoe soles are needed by mail carriers, deliverymen, and patrol officers to reduce injuries from slips and falls on ice. Such accidents are costly in terms of medical bills and lost time. Any solution, of course, must not be injurious to personal property.

While investigating an airplane skid problem, Mr. Jesse L. Kent of NASA's Langley Research Center found that strips of silicon carbide wet or dry sandpaper taped to shoe soles prevented skidding (Disclosure of Invention LAR-10297-1 submitted to the NASA Patent Office). In response to our Problem Statement, Mr. Kent suggested that shoe soles of a synthetic rubber be impregnated with finely powdered silicon carbide (150 grit minimum) for traction without damage. Samples of the silicon carbide sandpaper were forwarded to the postal service for evaluation. The postal service expressed interest and agreed to test sample shoe soles when they become available.

A one-month program is planned at NASA-Langley to develop nonskid soles for testing. The soles will be coated with grit in a yet-to-be-determined matrix and forwarded to the postal service for evaluation.

II ADDITIONAL ACTIVITIES

During the last six months of 1971, the NASA Technology Applications Team at SRI participated in several technical conferences and provided consulting services.

A. Texas Rehabilitation Association Convention

The SRI Technology Applications Team was invited to participate as a demonstrator at the Texas Rehabilitation Association Convention in Austin, Texas on July 14 and 15, 1971. Aerospace technology of potential benefit to handicapped persons was demonstrated. The Biomedical Applications Team at Southwest Research Institute demonstrated several items, and the SRI Team demonstrated the Langley Complex Coordinator. This device, which measures coordination, should prove very useful as a rehabilitation tool.

Mr. James T. Richards, Jr. of NASA TUO was a member of the panel discussing "Elimination of Barriers to Successful Rehabilitation."

B. NASA-Ames Research Center Conference

Mr. Joseph G. Berke, director of the SRI TATeam, was invited to speak at the NASA-Ames Conference, "Exploring Aerospace Technology for Solution of Community Problems," held on October 28, 1971 at Moffett Field, California. Mr. Berke discussed the operation of the TATeam and, by following one specific problem from initiation to solution, demonstrated the SRI Team methodology.

Other members of the SRI Team were on hand to answer questions raised by conference attendees, and to discuss some of the NASA technology on display at the SRI-TAT booth (Figure 4).

C. Assistance to the Alviso Economic Development Association

Members of the SRI TATeam were introduced to representatives of the Alviso Economic Development Association at the NASA-Ames conference described above. The purpose of the Association is to improve the economic

FIGURE 4 SRI TAT DISPLAY AT NASA-AMES CONFERENCE

and environmental conditions of the community. Working with the Technology Utilization Office at Ames Research Center, the SRI Team has provided NASA reports on earth dam construction, earth moving equipment, and related subjects.

D. Army Corps of Engineers Seminar on Technology Transfer

Mr. Joseph G. Berke participated in the seminar held on November 16, 1971 in Washington, D.C. to describe the NASA TAT program. Formal presentations were made by members of the NASA TATeam at Abt Associates, Inc., after which Mr. Berke described some NASA technology in the area of transportation, which is one of the SRI Team's mission areas.

E. American Public Works Association (APWA) Bridge Inspection Workshop

The first APWA Workshop was held in Chicago on December 13 and 14, 1971 to acquaint public works administrators with procedures for starting and managing a bridge inspection program. Federal law now requires biennial inspection of all bridge structures located on federal-aid highway systems. The responsibility for these inspections lies with those local (city or county) agencies that maintain the structures.

Mr. Michael Torgersen of the SRI Team attended to become more familiar with the technological problems connected with these inspections and to acquaint those present with the NASA TAT program and with specific pieces of NASA technology potentially applicable for bridge inspection and maintenance.

F. Association of American Railroads (AAR) Conference on Track/Train Dynamic Interactions

The AAR is preparing to sponsor a national research program on track/train dynamic interactions. A planning conference was held on December 15 and 16, 1971 in Chicago, Illinois to acquaint railroad managers, suppliers, and researchers with past and current activities in this field. Mr. Michael Torgersen of the SRI TAT attended the conference to determine what part the NASA Technology Applications Program can play in the forthcoming AAR reseach program.

III CONCLUSIONS

During this reporting period, it has become increasingly evident that consideration must be given to commercializing potential solutions. When users express interest in evaluating NASA technology that requires hardware, it is desirable early in the process to introduce a small business to the hardware, the need, and the potential market. The Complex Coordinator (C-13), the metal spot-test kits (C-22), and the reserve electrolyte battery cap (T-73) are currently in the process of becoming commercialized. Other items of NASA technology that will soon require industry participation include the thermoplastic material (T-53, 57), the flat surface light table (C-34), the residual stress measuring device (T-39, 64), and the brake lining material (T-62).

Moreover, if industry can be brought into the transfer process early, the cost of adaptive engineering and feasibility demonstration can probably be borne by the specific interested business, thus saving NASA funds for the problem-solution phases of the transfer program.

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Appendix

CURRENT PROBLEMS

Criminalistics

SRI/C-1 Measuring Reflection Spectra of Very Small Samples

A frequent problem in criminalistics is to identify an automobile from a small amount of paint left on an object it has scraped, especially in hit-and-run cases. Sometimes several square centimeters are left, sometimes only about a square millimeter. Identifying the paint can lead to identification of the make of car, and even the year and model sometimes.

SRI/C-3 Enhancing of Contrast on Questioned Documents

A nonreflective thin coating is needed to ascertain the ordering of writing at crossovers on questioned documents, when the question arises as to which of two crossing lines was written first. When liquid inks were in common use, this could be determined by the flow of ink from the later line into channels made by the passage of the earlier nib. This does not occur with the much more viscous ball point inks. For examination with a scanning electron microscope, a thin gold coating is applied, but its specular reflection makes microscopic examination very difficult. An optically dull substitute is desired.

SRI/C-4 Preserving Vaginal Swabs

Whenever a complaint is made that involves a possible prosecution for rape, a vaginal swab of the victim is secured. Experience shows that only a small fraction of the complaints develop into rape prosecutions. It would therefore be wasteful and prohibitively expensive to examine all these samples immediately. Preserving the samples at the point of origin is desired so that they can be examined when indictment is being considered--about one month.

SRI/C-5 Characterizing and Individualizing Hair

Among the most frequently found items of physical evidence are samples of hair. At present, it is not possible to establish positive identification on the basis of hair because only a broad classification can be obtained. It is desired that the possibility could be excluded that another person's hair would also match the sample.

SRI/C-8 Digitization of Fingerprints

Fingerprints are classified by a topological system (number of ridges between features) since successive prints of the same finger may vary in area covered and size. An automatic method is needed to record, classify, transmit, and retrieve fingerprints. At the present time most of this work is done manually.

SRI/C-9 Comparison and Classification of Evidence Items

An automatic comparison method is needed, not only to save time and labor, but also to create an objective record that can be introduced in evidence. This digital or analog system should be able to compare an item of physical evidence, such as a tool mark, bullet, or footprint, with a comparison item, and permit retrieval of matching items from a file.

SRI/C-12 Simple Analytical Methods for Drugs

There are two types of drug analysis: determination of the identity of seized samples and determination of drug levels in blood, urine, or other physiological specimens. The latter is much harder and may lead to wrongful convictions based on inferior evidence. Chemical separation procedures followed by gas chromatography, with collection of the effluents for infrared spectrophotometry or mass spectrometry, is a satisfactory method; however, most criminalistics laboratories do not have this equipment.

SRI/C-13 Effect of Drugs on Driving Ability

Illicit drugs, prescription drugs, and even some cold remedies that are sold over the counter can impair driving ability. However, law enforcement authorities have little or no quantitative information on their effects, especially as these relate to the manual skills, reaction times, and judgment factors. Such information would help obtain convictions of motorists who drive under the influence of drugs and might also, if widely disseminated, prevent people from driving dangerously.

SRI/C-15 Characterization of Glass

It is a deeply satisfying moment for an investigator when he can take a piece of glass found at the scene of a fatal hit-and-run accident and fit it precisely into the gap left in the broken headlight of the suspect's car. Unfortunately, the glass is usually shattered into fragments too small for reconstruction. Therefore, glass characteristics must be determined to compare with the known properties of glass in various makes of cars, including refractive index, elementary composition, and hardness.

SRI/C-16 Metal Detectors

Bullets, guns, keys, burglar's tools are some of the metal objects often sought during a police investigation. These may be imbedded in a wall or tree and may be ferrous or nonferrous. Metal detectors designed to detect land mines are not satisfactory for investigative purposes. Apparently specially designed detection instruments are needed.

SRI/C-18 Soil Identification and Individualization

In the commission of a crime, the perpetrator often leaves or picks up soil. Where soil from the crime scene can be correlated completely with soil found on a suspect, the first step in individualizing the specimens is achieved. The second step is to consider the probabilities of the environmental distribution of soil constituents, including mineral matter, biological matter, and artificial matter. Since specimen quantities are frequently amounts producing a clothing smear or filling a shoe nailhole, a systematic method is needed to qualitatively and quantitatively characterize soil constituents in small samples.

SRI/C-19 Differentiating Human Beings by Sweat Analysis

The stress during a criminal violation increases the chances that human sweat will be left at the scene through contact, such as fingerprints. Clothing left at the scene is apt to bear sweat stains. Information from an analysis of sweat is needed. This might include determination of human origin by precipitin test and blood group if a secretor (80% of population). Microscopic flora and fauna would bear consideration as to qualitative distribution among individuals.

SRI/C-20 Correlation of Tool Marks by Microtopological Analyses of Striae

Many crimes require the use of tools and these often leave marks. The microscopic variations, on the order of a microinch, in a crime scene mark and those of a mark made by a suspected tool are juxtaposed with a comparison microscope by present techniques. Low-angle incident light on the marks produces a hill-and-vale rendition of the striae. These are adjusted by relative movements to align the two marks, resulting in mismatches. A technique is needed for retrieving profile information from striae produced by tools and correlating profiles from the same tool at different times.

SRI/C-21 Methods of Testing Tools for Agreement with Production Specifications

In scientific crime detection, recovered tools or broken tool parts can provide clues to perpetrators if the tools can be traced to a manufacturer or fabricator or if the manufacturing mode can be specified. Where no trademark or other identification is available, a surface finished by a grinding wheel will present surface discontinuities that can be traced. Information on materials, forming procedures, and finishing techniques obtainable from the final tool product can be a tremendous aid to criminal investigation.

SRI/C-22 Simple Methods of Analysis for Metals and Metal Products

Metal objects are frequent items in criminal cases, e.g., obliterated serial number plate, toolmark on lock, bomb fragments. Determination of metallic composition can facilitate other analyses as well as serve to identify the source. A spectrographic approach is not always available in crime laboratories, whereas a wet chemical approach is easily utilized.

SRI/C-24 Retrieval Methods for Toxicological Case Information

The number of drug abuse cases, fatal and nonfatal, is on the order of 2 million cases per year. A complete toxicological investigation is essential in each case of death and in many nonfatal cases, so that ultimately the roles, direct and indirect, of specific exogenous chemicals may be assessed. An information storage and retrieval system of a generalized nature is desired for data from toxicological cases.

SRI/C-25 Photographic Methods for Surface Characteristics

Surface characteristics are often difficult to photograph because of problems of reflectance or lack of contrast, or both. Crime laboratories frequently have very minute characteristics as important items of evidence (in addition to visual analysis).

SRI/C-26 Educational Methods in Analysis

Approaches to the analysis of an unknown are critical elements in the education of a forensic scientist. The need is expressed for methods designed to enhance the orientation of a scientist to, or to guide the development of a student in, the selection of retrieval schemes for the informational contents from an object of evidence.

SRI/C-27 Residues from Hand Sweat or Film

Fingerprints left at the scenes of crimes are usually invisible and are found on a variety of surfaces. Fairly precise information as to the nature of the film found on human hands and the deposits from the film on various surfaces is needed. With this information, new and improved methods can be formulated for detection and retrieval.

SRI/C-28 Low Light Level Photography

A number of law enforcement agencies have expressed the need for an improved system to photograph individuals at low ambient light levels without alerting them. There are several commercial systems that supposedly perform this task, most using fast film and electronic light amplifications. Actual photographs exhibited by the police departments indicate that these systems are inadequate for identification of the persons depicted.

SRI/C-29 Enhanced Discrimination of Photographic Negatives

Documentation of crime scenes and related matters frequently includes photographs. While this form of recording is capable of storing information in high density at a low level of abstraction, the limitations of the human eye in discriminating monochromatic variations prevent retrieval of significant detail. The human eye's ability to distinguish color hues provides a method to retrieve the stored information.

SRI/C-30 Obliterated Serial Number Restoration

Serial numbers stamped in metal (firearms, motor blocks, and so forth) are filed or otherwise altered in an attempt to remove or change the identification. Methods are desired to retrieve the original numbers.

SRI/C-31 Material Source Analysis by Cathodoluminescence

Materials of both organic and inorganic nature can be differentiated by electron-stimulated luminescence. The characterization of gem stones and pottery by this means suggests an approach to source identification of physical evidence by comparison of suspected and known specimens.

SRI/C-32 Training Aids in Crime Scene Searches

The retrieval of possible physical evidence from crime scenes is handled largely by field investigators, i.e., from evidence technicians to patrol officers. Apprenticeship training, possibly with some direction by laboratory personnel, constitutes the basis for the investigator's recognition and collection of physical evidence. Training aids are needed to improve an investigator's perception of physical evidence during the learning process.

SRI/C-33 Morphological and Anatomical Analyses of Materials by Scanning Electron Microscope

Taxonomic development in physical evidence has been severely constrained by the rapidly decreasing depth of field with the increasing magnification of stereomicroscopy and microscopy and by the 100- to 200-nm resolution limit in microscopy. The scanning electron microscope provides vastly improved depth of field and resolution. There is interest in using this instrument to enhance potential evidence taxonomy.

SRI/C-34 Inexpensive Light Table

Criminalistic laboratories receive a wide variety of objects and materials for examination. A light table is desired for microscopic examination of debris, such as hairs, fibers, and soil. To prevent destruction or alteration of the samples, the table surface must illuminate without generating heat.

SRI/C-35 Collection of Arson Residual Vapors

A method is needed for collecting the flammable vapors at an arson scene for laboratory analysis. Currently, a sample is taken of the charred residue when flammable vapors are detected. These samples are not in a suitable form for analysis. With the increase in arson cases, this problem is acute in many crime laboratories.

SRI/C-36 Determination of Blood Stain Age

In many crimes of violence, blood is left at the scene and may have been picked up by the suspect. The blood can be tied to the victim by grouping procedures; however, if there was a continuing relationship between the victim and suspect, the blood may have come from an unrelated incident. Knowing the age of the blood stain would resolve these doubts.

SRI/C-37 Fingerprint Age Analysis

The finding of a person's fingerprints on an object is positive proof that he has touched the object. Currently, however, the criminalist has no way of determining when the fingerprints were left. In many criminal cases, it is important to establish the time of the crime as well as the place.

Transportation

SRI/T-2 Vehicle Locator

Transit operators, police, and highway patrols need an inexpensive device to track a vehicle and compute its location coordinates for automatic reporting to a central dispatcher. A system that would transmit the vehicle's location when interrogated by the dispatcher would permit identification of its location when the officer is occupied outside the vehicle.

SRI/T-19 Nondestructive Measurement of the Thickness of Portland Cement

It is necessary in both newly laid and older Portland cement concrete pavements to determine the thickness with some degree of accuracy. For new pavements, measurement is necessary to ensure that construction specifications have been met. For older pavements, load carrying capabilities must be assessed. A rapid, inexpensive, and accurate method is needed to measure the thickness of the finished Portland cement concrete pavements, by nondestructive means.

SRI/T-23 Measurement of Pavement Surface Texture

The skid-resistance of automotive tires is a function of the surface texture of the pavement. Several methods have been developed to measure texture and correlate it with skidding and hydroplaning, but all are time-consuming to use. A rapid test, preferably electronic, is needed to measure the surface texture of highway pavement.

SRI/T-24 Profile Measurement of Pavement Surfaces

Today's modern highways demand smooth surfaces to provide for safety and comfort at high speeds. Surface tolerances for new pavement construction are ordinarily given in terms of a maximum allowable vertical deviation from a true plane in a given horizontal distance. A high speed, accurate, profile measuring device to be operated at maximum automobile highway speeds is needed.

SRI/T-27 Reflective Signs

Highway signs use retro-reflective materials in the form of sheets or plastic buttons, all having a smooth, transparent surface covering. When this surface is covered with dew, the refraction and scattering of light from the water droplets destroy the retro-reflective character of the material. A material or coating is needed to preserve these retro-reflective properties in dew-forming conditions.

SRI/T-35 On Site Compression Strength Measurements of Structural Pavement Sections

The strength of a given concrete varies with a number of factors, the most important being compressive strength of the cement paste, gradation and strength of the aggregates, the mix proportions, the water-cement ratio, and curing methods. A rapid, cheap, and accurate method is needed to measure the structural strength of the finished concrete pavement.

SRI/T-37 Ultraviolet Degradation of Highway Signs

Currently the reflective material used on highway signs degrades after a period of time due to exposure to the sun's ultraviolet radiation. A method or process or a new material is needed that will prevent or resist the degrading effects of ultraviolet radiation in reflective materials.

SRI/T-38 Detection of Incipient Roller Bearing Failure on Rail Cars

Derailment is a typical consequence of bearing failure. A rate of failure that is tolerable in routine freight service will be intolerable in very high speed passenger service for which a lower friction, more reliable bearing than the journal bearing is necessary. Roller bearings are capable of long, trouble-free service, but they lack the early-warning characteristics of the journal bearing. Therefore, railroads follow strict rules about inspection procedures. In addition, bearings on cars that have been involved in collisions or derailment must be disassembled and inspected in an expensive shop operation. A device is needed to warn of incipient failure of roller bearings on rail cars.

SRI/T-39 Detection of Locked-In Stress in Long Welded Rails

Modern railroad track is laid in very long, continuous lengths of welded rails. Thermal stresses build up in such a strip, but are normally distributed along the rail. If ties, ballast, or anchors are disturbed by maintenance or repair work performed at a different temperature from that at which the rail was laid, stress may be relieved in one section and accumulate in another. On a hot day a sufficiently large compressive stress may build up to buckle the rail despite the lateral restraint by the ties and form a sun kink. A device is needed that can travel along a steel rail and measure its stress condition.

SRI/T-40 Nondestructive Testing of Rail Butt Welds

The quality of welds in continuous welded rail is very important to the safety of the resultant track. The shop welding process is fast. The welds are checked while still cooling by Magnaflux device; however, internal defects are easily missed. The ultrasonic test used in the field is not applied to shop welds because the necessary cooling time is too long. A nondestructive test is needed that can function with the rail at 500°F minimum, preferably to 900°F.

SRI/T-42 Instrumentation for Close Range Photogrammetry

Measurement of the very slight motions of large structures such as bridge pilings, base structures, and large earth fills at distances of 20 to 200 ft is desired. In many cases, the item under study is inaccessible to routine types of instrumentation and measurement techniques.

SRI/T-43 Portable Device for Recording Eye Motion

A portable device is needed to monitor eye motion of vehicle drivers. How a highway sign is read, whether colors or letter sizes have an effect, whether flashing lights near a highway sign are distracting, and how fatigue, narcotics, and pollution combine with the other questions, are of interest to researchers in the highway sign field.

SRI/T-44 Frost Detection and Removal from Bridge Decks

Ice or frost on bridge roadways, at a time when the approach pavements remain ice- and frost-free, has been accepted as a safety hazard in many states. Because the bridge itself is exposed to moisture and winds from all sides, ice and frost generally form on the decks before appearing on the approaches. A detector is needed to indicate the formation of ice or frost on the roadway of a highway bridge. Also needed is a method, triggered by the detector, to remove such ice and frost.

SRI/T-45 Nondestructive Testing of Large Metal Structures

Methods are required to test large metal structures, especially bridges, for structural integrity. Solutions should consider the impedance to smooth traffic flow during testing, simplicity of the test and reliability of operation. There are approximately 500,000 bridges on U.S. highways and no definitive way to determine which ones are structurally safe.

SRI/T-46 Improved Rear Vision Device

The lack of a clear 180° rear view from vehicles poses a continuous safety problem. An improved rear vision device is needed for motor vehicles.

SRI/T-47 Sewage Processor for Highway Rest Stops and Wilderness Areas

Since most highway rest stops are located in rural areas, some thought must be given to preserving the ecological surroundings by thoroughly processing the sewage effluent from the comfort station. A self-contained sewage processing unit is desired, requiring little maintenance.

SRI/T-49 Air Purification for Toll Booths

There is a need for an economically feasible system for providing purified air to toll booths in an environment having a high concentration of compounds from vehicle exhausts.

SRI/T-50 Lightweight Scaffold Material

The cost of painting the San Francisco Bay Bridge amounts to more than $1 million annually. An appreciable percentage could be saved by lessening the time required to move scaffolds and lessening the maintenance of the scaffolds. A strong, durable, lightweight scaffolding material is needed.

SRI/T-51 Corrosion and Contaminant Removal from Steel

To ensure the structural soundness of a bridge, it is necessary to periodically remove all corrosion and reapply protective coatings. Sandblasting, the most successful method at present, requires expensive, bulky equipment and clothing. A method is needed to remove the corrosion and contaminants from bridges without leaving a harmful residue.

SRI/T-52 Nondestructive Testing of Cables

There is no nondestructive method for ascertaining the load-carrying capacity of the stranded cables used on bridges. Bridge loads are increasing, and public safety demands that a cable's conditions be known since wear, corrosion, or fatigue may drastically reduce its safety margin.

SRI/T-53 Concrete Repair Material

A strong, quick setting, nontoxic material is needed for repair of the concrete on bridge decks and approaches. The repairs must be completed during non-rush hours when closing a lane is less apt to impede the flow of traffic.

SRI/T-54 Flameless Pavement Heating Device

Many northern states are faced with the problem of repairing roads in below freezing weather. A device or method is needed to heat the asphalt pavement to a depth of six to eight inches.

SRI/T-55 Impact Resistant Rollers

The U.S. Postal Service uses conveyor belts to carry sacks of mail into and out of trailers. The sacks are stacked 7 ft high, and in a typical trailer unloading they are swung down by the closure strings and dropped onto the conveyor belt. The resulting impact of about 400 foot-pounds damages the rollers.

SRI/T-57 Concrete Sealant

A surface sealant is needed to prevent the admittance of moisture to and the associated deterioration of reinforcing rods in concrete. The soundness of structures, especially bridges, is endangered after prolonged exposure.

SRI/T-58 Instrumentation for an Impact Sled

Building of a pneumatic impact sled is planned for studying such things as collapsible dash panels.

SRI/T-59 Corrosion Protection for Submerged Pilings

Conventional construction practices require that the lower end of a piling be driven into mud and the upper end encased in concrete. A method is needed to stop or slow the galvanic corrosion by saltwater of the transition zone, the piling section not encased in concrete and not sufficiently sealed by the mud.

SRI/TR-60 Trackside Clearance Measurements

A device or method is needed by the railroads to monitor and maintain the minimum clearances between the rolling stock and surrounding obstructions such as tunnel walls, sides of buildings, bridge members, and signals. Changes in the clearances may be caused by earth movement, track maintenance and repairs, new construction, or even high or wide loads on the rail cars themselves.

SRI/T-61 Pavement Striping

Few pavement marking materials last longer than two years, some only two months. The markers may be abraded by tires, chipped by studded snowtires, dislodged by snowplows, or peeled by moisture and frost. Replacement of striping is expensive, striping equipment impedes traffic, and the workmen are endangered. A durable pavement striping material is needed that is reflective in wet, dark periods when a driver's need for guidance is most critical.

SRI/TR-62 Improved Brake Lining Material

New materials for brake linings are greatly needed for increased wear and safety. The U.S. Postal Service is anxious to increase the time between relinings (600 to 6000 miles) for postal vehicles. The railroads are interested in new materials to replace the metal shoes currently in use on railcars. These metal shoes cause sparks that have set trackside weeds and boxcar bottoms on fire. In addition, wheels heated by metal linings tend to be thermally loaded and stressed.

SRI/TR-63 Fire Protection of Railroad Tank Cars

There is a need for fire protection and prevention of catastrophic failures of tank cars in post derailment environments. Fire retardant or protective coatings are required to maintain the 5/8-inch steel tank cars at 800°F or below for 1/2 to 4 hours during a fire.

SRI/TR-64 Detection of Residual Stresses in Rail Car Wheels

Derailments have occurred because of the catastrophic failure of rail car wheels. These failures occur when stresses resulting from known vertical and lateral operating loads are superimposed on unknown residual stresses in the wheel. There is a need for a method of inspecting rail car wheels in the field to determine if residual stresses are above a critical level.

SRI/T-65 Contour Plotting System for Highway Engineering

Large-scale, small contour interval maps are needed for highway planning. A computer-generated, contour plotting system will be used to chart the areas being considered for highway construction.

SRI/TR-66 Railroad Ties

Wood, by far the most common material used for railroad ties, is in short supply and therefore expensive. In addition, it has a shorter life than most roadbeds. Sixteen million ties must be replaced each year and there is no adequate means for disposing of them. Material with greater availability and durability is needed--perhaps one that can be repaired instead of being replaced.

SRI/TR-67 Freight Car Shock/Load Measuring and Recording System

Claims for freight damage cost the nation's railroads about a quarter of a billion dollars each year. With a better knowledge of the actual freight environment, they could prevent freight damage and the resulting investigation claims. The railroads need an inexpensive ($\approx$ \$1000), portable, time referenced, three-axes impact amplitude recorder that can monitor and record 0 to 15 g, 0 to 60 cps loads unattended for up to eight days. In addition, it must be possible for nontechnical personnel to play back and reset the recorder.

SRI/TR-68 Protective Coating for Rail Car Identification Labels

Almost two million railroad cars are in operation today. Most of these are equipped with retro-reflective coded labels for Automatic Identification (ACI). To keep these labels clean for proper function, the railroads need a clear, durable, protective coating, that is easily applied, quick curing, and either repels dirt or can be cleaned without damage to the reflective properties of the label.

SRI/TR-69 Low Temperature Gasket Material

When a freight train is formed, each rail car air brake system is joined to the systems of adjacent cars by air brake hose couplings, and the entire braking system is pressurized to 90 psi. A failsafe system will cause each car's brakes to be automatically applied when a certain reduction in pressure occurs. During cold weather, air leaks at the hose couplings result from degradation of the gasket material and the pressure drops. This, of course, stops the train and it cannot be restarted until the leaks are located and the gaskets replaced. To avoid this loss of time and money, an improved gasket material is needed, or a new design for rail car air brake hose couplings.

SRI/TR-70 Rail Joint Insulating Material

Rail joints must provide the same strength, stiffness, flexibility, and uniformity as rail. Continuous welded rail is being increasingly used and is alleviating some of the maintenance problems of ordinary rail joints. Some joints must meet the added requirement of separating signal circuit blocks. Recent work in the area of glued insulated joints using epoxy glues and fiberglass insulating sheets has been very encouraging, with the exception of the gap that must be left at the rail ends. An insulating material having suitable mechanical properties is needed to fill this end post position.

SRI/TR-71 Shatterproof Windshield Material

The Association of American Railroads has need for a shatterproof, transparent material for use in locomotive and caboose windshields and windows. Vandalism has become a concern of the railroads, and an impact resistant material is desired that has optical properties and hardness comparable to glass.

SRI/TR-72 Determining Bridge Collapse Potential in Areas Prone to Sinkholes

In addition to the usual structural inspection of bridges, Florida will be required to test the foundation conditions at each state-maintained bridge in areas prone to sinkholes. Since almost all of Florida's 5000 highway bridges are in such areas, a method of detecting collapse potential is desired requiring little or no drilling, which is time consuming.

SRI/T-73 Vehicle Battery Check

In police departments and other agencies having large fleets of vehicles, there is a need for a faster battery check. Although each battery check requires only about two minutes, the time required to check a fleet of vehicles is considerable. Most of this time is spent in unscrewing and rescrewing the battery caps.

U.S. Postal Service

SRI/PS-1 A Novel Method for Cancelling Stamps

Current cancellation processes require turning the letter so that the stamp meets the cancelling device. However, these machines have a rather high rejection rate, and a considerable fraction of the mail must be hand cancelled. A novel alternative method of cancelling stamps is being sought.

SRI/PS-2 Environmental Effects on Human Factors

A person's ability to perform various mental and physical tasks is influenced by his environment. In a postal facility, the noise, ventilation, lighting, and other factors may have a bearing on human comfort and performance. Information and techniques are sought to optimize the environment for maximum comfort, safety, and efficiency.

SRI/PS-3 Fluidics for Mail Handling

New advances in mail handling technology are incorporating pneumatic controls for moving and separating mail. Parcels move on a cushion of air; letters are lifted over airfoils and separated by degree of lift (weight). NASA technology in fluidic controls, lift theory, wing design, and nozzel configurations should be very valuable in developing new techniques.

SRI/PS-4 Repairing or Rewrapping Damaged Packages

Each year the Postal Service must repair or rewrap approximately 10 million parcels damaged as a result of processing or faulty packaging by the mailer. Present methods of repair are taping, string-tying, heat sealing with a plastic wrap, or a combination of the three. A method is needed that is less costly in terms of man-hours and material.

SRI/PS-5 A Lightweight, Durable Mail Bag Material

At present, the primary containers for transporting mail are the canvas and Resintex (a tightly woven nylon) mail bags. Because of the frequent handling they receive and the assorted shapes and weight of the parcels they contain, mail bags are subject to excessive wear and tear, resulting in a considerable expenditure each year for repair and replacement.

SRI/PS-6 Improved Traction for Mail Carriers

Injuries to mail carriers from slips and falls on ice cost approximately $1,400,000 annually. Improved foot traction is needed to reduce accidents. The solution must be inexpensive, lightweight, durable, and, of course, harmless to personal property.

SRI/PS-7 Pallet Scheduling

The U.S. Postal Service is conducting an experimental program to determine the cost effectiveness of shipping mail on reusable pallets, which are sent to large mail users. A mathematical model is desired for scheduling the use of these pallets.

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