UMTRI
RESEARCH REVIEW

• University Of Michigan Transportation Research Institute • January–March 2005 • Volume 36, Number 1 •

Inside:

on page 1:

Daytime Conspicuity of Pedestrians

UMTRI

RESEARCH REVIEW

• UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE • JANUARY–MARCH 2005 • VOLUME 36, NUMBER 1 •

ISSN 0739 7100

Writer and Editor: Monica Milla
Designer: Shekinah Errington
Cover Photography Credits: UMTRI—Shekinah Errington
Printer: Michigan Business Services

The UMTRI Research Review is published four times a year by the Research Information and Publications Center of the University of Michigan Transportation Research Institute, 2901 Baxter Road, Ann Arbor, Michigan 48109-2150 (**http://www.umtri.umich.edu**). The subscription price is $35 a year, payable by all subscribers except those who are staff members of a State of Michigan agency or an organization sponsoring research at the Institute. See the subscription form on the inside back cover. For change of address or deletion, please enclose your address label.

Daytime Conspicuity of Pedestrians

Despite pedestrian deaths having decreased by 16 percent since 1993, 4,749 pedestrians were killed in traffic crashes in the United States in 2003. Of these deaths, 35 percent occurred in daylight (U.S. DOT, 2004). Daytime pedestrian conspicuity remains a serious issue, particularly as it applies to the design of high-visibility safety apparel for occupations exposed to traffic, like road construction.

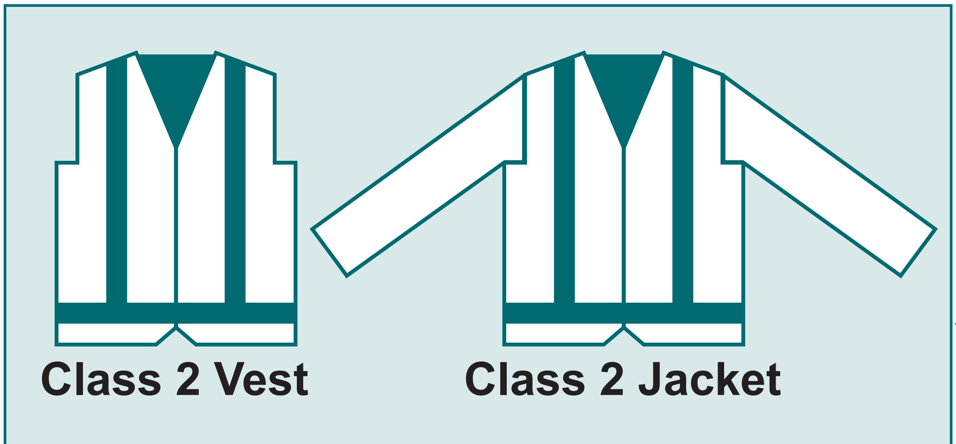
UMTRI researchers Jim Sayer and Mary Lynn Mefford investigated the daytime conspicuity of high-visibility safety apparel. Earlier studies investigated many aspects of the nighttime visibility of such garments, and this was the premier investigation into daytime conspicuity.

Background

A naturalistic, daytime field study was conducted to assess the effects of garment color, the amount of background material, pedestrian arm motion, scene complexity, and driver age on the daytime conspicuity of personal safety garments. Distances at which drivers of an instrumented research vehicle detected pedestrians outfitted in the fluorescent garments were recorded. Drivers had no prior knowledge of where along the fixed 31-km route pedestrians would be located, nor of the number of pedestrians positioned along the route. All of the challenges normally encountered when driving on public roadways were present (other motor vehicles, traffic signals, signs, pedestrians, and bicyclists), thus imposing an ecologically valid level of workload on the drivers.

Four new garments compliant to ANSI/ISEA 107-2004 were used in this study: a class 2 vest and a class 2 jacket with fluorescent yellow-green background material, and a class 2 vest and a class 2 jacket with fluorescent red-orange background material. Vests utilized approximately 0.9 m^2 of fluorescent background material, whereas the jackets used approximately 1.1 m^2. All retroreflective trim was silver, 50-mm wide, cloth-backed, exposed reflective-lenses material. Each garment contained 0.17 m^2 of retroreflective trim.

For each trial, an experimenter was positioned along the road (at the edge of the road or on a sidewalk, depending on the type of street), wearing one of the four types of retroreflective garments and facing oncoming traffic.



UMTRI / MARY LYNN MEFFORD, SHEKINAH ERRINGTON

The experiment examined the daytime conspicuity of pedestrians wearing fluorescent yellow-green and fluorescent red-orange class 2 vests and jackets.

Experimenters kept their arms stationary in half of the trials, and swung or moved them in the other half.

Two levels of environmental complexity were examined: a low complexity environment characterized by low traffic density and sparse housing/businesses, and a medium complexity environment associated with strip malls and other business areas and higher traffic densities. A mixed-design, repeated-measures analysis of variance was performed on the data. The within-subject variables were garment type (two levels), garment color (two levels), arm motion (two levels), and scene complexity (two levels). The between-subject variable was driver age (two levels). The dependent measure was the distance at which a pedestrian (the experimenter) was detected.

continued...

Low complexity

Results

Scene complexity was the only main effect variable to significantly affect the distance at which a pedestrian wearing a fluorescent safety garment was detected. Garment color (fluorescent yellow-green or fluorescent red-orange), garment type (class 2 vest or class 2 jacket), arm motion (arms in motion or stationary), and driver age (younger or older) did not significantly affect the distance at which pedestrians were detected. The results contribute to a growing body of research aimed at a more general understanding of what garment characteristics enhance pedestrian conspicuity in both day and night conditions.

Pedestrians were detected at longer distances (about 70 m) in lower complexity scenes than in medium-complexity scenes. This result is consistent with research that has been preformed under night-time conditions where the conspicuity of retroreflectors on high-visibility garments was found to be significantly affected by the complexity of the surrounding scene (Sayer and Mefford, 2004). In both the current and previous research, the tasks have been that of search conspicuity, with the drivers having no prior knowledge of where a pedestrian might be located, but knowing that pedestrians with high-visibility garments will be present somewhere along the route. In essence, this task becomes a signal-to-noise ratio problem. The more background information a driver has to search through, or to respond to, the longer it is likely to take to locate specific targets.

Pedestrian arm motion did not have a statistically significant effect on detection distances. Pedestrians who moved their arms were detected at about the same distances when wearing the class 2 vest (239 m) as when wearing the class 2 jacket (233 m). However, motionless pedestrians wearing the class 2 jacket were detected at substantially longer distances (243 m) than were motionless pedestrians wearing the vest (208 m).

Medium complexity

PHOTOS: UMTRI / MARY LYNN MEFFORD

PHOTOS: UMTRI / SHEKINAH ERRINGTON

In contrast, in a pervious nighttime study (Sayer and Mefford, 2004), arm motion did significantly improve pedestrian detection distances, independent of the type of retroreflective treatment. Sayer and Mefford theorized that arm motion resulted in a "flashing" appearance of the retroreflectors in the nighttime condition. Because the current study was conducted during daylight hours, when the silver retroreflective trim is unlikely to contribute much to a garment's conspicuity, it is perhaps not surprising that a significant effect of arm motion was not observed.

Detection distances between the fluorescent yellow-green and the fluorescent red-orange garments were not significantly different, nor were there any significant two-way interactions involving garment color. Consequently, to the degree that there is no color contrast incorporated into a garment either through the use of fluorescent fabric or combined-performance materials (i.e., fluorescent colored retroreflective trim), there appears to be no difference in conspicuity between the fluorescent yellow-green and fluorescent red-orange background materials. The effect on the conspicuity of safety garments incorporating contrasting fluorescent colors remains to be studied under similar naturalistic conditions.

There was no main effect of garment type on the conspicuity of pedestrians during the daytime. This result was similar to those reported previously

continued...

in a nighttime condition (Sayer and Mefford, 2004).

Lastly, the detection distances of high-visibility garments were not affected by driver age, even though older drivers had a somewhat lower mean visual acuity. In fact, three of the four missed trials were associated with the younger drivers. Consequently, unlike some of the previous studies examining the nighttime conspicuity of high-visibility garments incorporating retroreflectors (Sayer and Mefford, 2002), daytime conspicuity of high-visibility garments does not appear to be affected by driver age under the conditions examined.

Recommendations

Previous research on pedestrian conspicuity has been largely focused on dark or nighttime conditions, where pedestrian fatalities are highly overrepresented relative to the amount of pedestrian travel occurring during the nighttime hours. However, in many instances, high-visibility garments need to make pedestrians conspicuous both during the day and night. It is unrealistic to assume that pedestrians will have multiple garments at their disposal which can be readily switched due to changes in the ambient illumination, particularly around dusk and dawn, or due to changes in the complexity of the pedestrian's surroundings. Therefore, it is important to understand how the various design elements of high-visibility garments might individually, as well as collectively, contribute to pedestrian safety under a wide range of conditions. For example, the current study found no daytime benefit of added fluorescent material contained

PHOTOS THIS SPREAD: UMTRI / SHEKINAH ERRINGTON in a jacket relative to a vest. However, that does not mean that the presence of the jacket's sleeves is not critical to the placement of retroreflective trim for nighttime conspicuity.

While more remains to be learned about how the various characteristics of a high-visibility garment contribute to its conspicuity, more research needs to be conducted during periods of transitional illumination, such as dusk and dawn. RR

UMTRI at the VII Meeting

UMTRI director Peter Sweatman and Engineering Research Division head Tim Gordon attended ITS America's Vehicle Infrastructure Integration (VII) Meeting in San Francisco in early February, 2005. The VII is a coalition that was established between the federal government and automakers to perform research to better understand vehicle-to-vehicle and vehicle-to-highway communications. This meeting was the first time the plans of the project have been opened to a wider audience.

The findings of the VII coalition will allow better decision making on the possible deployment of a dedicated short-range communications (DSRC) standard. This plan would involve standardized electronic devices being placed in all new cars and along the roadway to monitor traffic. "The main applications of the technology are safety-related, like reducing risks at intersections," Sweatman says. "That means if a decision is made for a vehicle-highway communications standard, it needs to be a long-term, widely deployable system that is highly reliable and well-maintained. If and when this is implemented, it will change the way we drive forever."

For more information on the meeting (including agendas and presentations), see **www.itsa.org/vii_meeting.html**.

UMTRI / SHEKINAH ERRINGTON

Bob Ervin, Retired Division Head

Fuel Saving Technologies of Alternative Powertrains

An UMTRI report outlines possible scenarios for U.S. sales of vehicles with two alternative powertrains, gas-electric hybrids and advanced diesels. The report, Fuel-Saving Technologies and Facility Conversion: Costs, Benefits, and Incentives, is written by Patrick Hammett, Walter McManus, and Maitreya Sims of OSAT and Daniel Luria of the Michigan Manufacturing Technology Center.

The authors model the costs of producing hybrids and advanced diesels and forecast the likely job consequences of their increasing market share. The study projects that hybrids and advanced diesels may account for as many as 1.8 million sales in reasonably robust market of 16.6 million light vehicles in 2009.

The study was funded by the National Commission on Energy Policy and the Michigan Environmental Council.

You can access the report in PDF format at **http://tinyurl.com/9wpez**.

Bob Ervin Wins SAE Award

Professor emeritus Robert D. Ervin received the Society of Automotive Engineers (SAE) Delco Electronics Intelligent Transportation Systems Award for his outstanding leadership in and contributions to the advancement of intelligent transportation systems (ITS). Criteria for the award include the significance and originality of the individual's contribution to ITS, the impact and influence of the individual's work on the progress and development of ITS, and recognition by the individual's peers of both leadership and participation in bringing to realization the important objectives of ITS.

continued...

Ervin is retired from UMTRI where he spent a distinguished, thirty-five year career, which culminated in his serving as the head of the Engineering Research Division. He directed research on the dynamic process of motor vehicle control with an emphasis on crash avoidance technology. He is the cofounder of the University of Michigan's Intelligent Transportation Systems program and served in many national and international capacities to promote meaningful research on applying technology to further advance safe driving.

Ervin has authored hundreds of technical papers and reports in the fields of vehicle dynamics, motor vehicle safety, and intelligent transportation systems. He has been active with SAE for many years. He helped found the Society's ITS Program Office (now the ITS Division) in 1992 and helped found Mobility 2000 in the late 1980s, from which ITS America was formed. Ervin also served on several Transportation Research Board committees and special study groups of the U.S. Department of Transportation. He holds a bachelor's degree from the University of Detroit and a master's from Cornell University, both in mechanical engineering.

This honor was also awarded to David L. Acton of General Motors.

UMTRI Collaboration

UMTRI director Peter Sweatman visited Virginia Tech Transportation Institute (VTTI) in late February, 2005. Sweatman and Tom Dingus, director of VTTI, discussed the facilities and capabilities of their organizations and ways to cooperate to improve the research environment. They agreed to combine efforts to both influence the federal government to create more projects like Vehicle Infrastructure Integration (VII; *see article on page 6*) and to help determine how the VII program is structured.

UMTRI Introduces New Logo

UMTRI has updated its logo to keep in sync with the University of Michigan's latest graphic-identity guidelines. The new logo reinforces that UMTRI is part of the University, while also expressing our unique identity.

Specifically, we have removed the University seal, which is now reserved primarily for use on diplomas and other official documents. We have also incorporated the "block M," which has long been associated with the University. It is one of the most widely recognized logos in the country, having enjoyed wide exposure through the University's intercollegiate athletics programs. The block M is now also part of the University's official identity, and it features in the logos of many schools and departments across campus. RR

Hot Off The Press

Journal Articles

Stapp Car Crash Journal. Volume 48, November 2004. Stapp Association, Ann Arbor, Mich. Published by Society of Automotive Engineers, Warrendale, Pa. 525 p. Report No. SAE P-389.

Gillespie, T.D. 2004. "Foreword: road profiles: measurement, analysis, and applications." Michigan University, Ann Arbor, Transportation Research Institute, Engineering Research Division. 2 p. *International Journal of Vehicle Design.* Vol. 36, no. 2/3 (2004), pp. 101–102.

Karamihas, S.M. 2004. "Development of cross correlation for objective comparison of profiles." Michigan University, Ann Arbor, Transportation Research Institute, Engineering Research Division. 21 p. *International Journal of Vehicle Design.* Vol. 36, no. 2/3 (2004), pp. 173–193.

Klinich, K.D.; Ebert, S.M.; Van Ee, C.A.; Flannagan, C.A.C.; Prasad, M.; Reed, M.P.; Schneider, L. W. 2004. "Cervical spine geometry in the automotive seated posture: variations with age, stature, and gender." Michigan University, Ann Arbor, Transportation Research Institute. 30 p. *Stapp Car Crash Journal.* Vol. 48 (Nov. 2004) pp. 301–330. Sponsor: Ford Motor Company, Dearborn, Mich. Report No. 2004-22-0014.

Sayer, J.R.; Mefford, M.L. 2004. "High visibility safety apparel and nighttime conspicuity of pedestrians in work zones." Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 10 p. *Journal of Safety Research* Vol. 35, no. 5 (2004), pp. 537–546. Sponsor: Michigan University, Ann Arbor, Industry Affiliation Program for Human Factors in Transportation Safety.

Shope, J.T.; Molnar, L.J. 2004. "Michigan's graduated driver licensing program: evaluation of the first four years." Michigan University, Ann Arbor, Transportation Research Institute, Social and Behavioral Analysis Division/ Michigan University, Ann Arbor, School of Public Health. 8 p. *Journal of Safety Research.* Vol. 35, no. 3 (2004), pp. 337–344. Sponsor: National Highway Traffic Safety Administration, Washington, D.C.

Sivak, M.; Flannagan, M.J.; Schoettle, B.; Adachi, G. 2004. "Color separation near the cutoff of low-beam headlamps." Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 12 p. *Leukos* Vol. 1, no. 2 (Oct. 2004), pp. 57–68. Sponsor: Michigan University, Ann Arbor, Industry Affiliation Program for Human Factors in Transportation Safety.

Sivak, M.; Flannagan, M.J.; Schoettle, B.; Nakata, Y. 2004. "Performance of the first generation of HID headlamps in the U.S." Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 17 p. *Leukos* Vol. 1, no. 1 (July 2004), pp. 67–83. Sponsor: Michigan University, Ann Arbor, Industry Affiliation Program for Human Factors in Transportation Safety.

Sivak, M.; Flannagan, M.J. 2004. "Consequences for road traffic fatalities of the reduction in flying following September 11, 2001." Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 5 p. *Transportation Research. Part F, Traffic Psychology and Behaviour.* Vol. 7F, no. 4–5 (July/Sept. 2004), pp. 301–305.

Sivak, M.; Schoettle, B.; Flannagan, M.J. 2004. "LED headlamps: glare and colour rendering." Michigan University, Ann Arbor, Transportation Research Institute, *Human Factors* Division. 11 p. *Lighting Research and Technology* Vol. 36, no. 4 (2004), pp. [295]–305. Sponsor: Michigan University, Ann Arbor, Industry Affiliation Program for Human Factors in Transportation Safety.

Tsimhoni, O.; Smith, D.; Green, P. 2004. "Address entry while driving: speech recognition versus a touch-screen keyboard." Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 11 p. *Human Factors.* Vol. 46, no. 4 (Winter 2004), pp. 600–610. Sponsor: Mitsubishi Motors Corporation, Tokyo (Japan).

Vivoda, J.M.; Eby, D.W.; Kostyniuk, L.P. 2004. "Differences in safety belt use by race." Michigan University, Ann Arbor, Transportation Research Institute, Social and Behavioral Analysis Division. 5 p. *Accident Analysis and Prevention.* Vol. 36, no. 6 (Nov. 2004), pp. [1105]–1109. Sponsor: Michigan Department of State, Lansing.

Technical Reports

Devonshire, J.M.; Sayer, J.R. 2004. *Effects of IRR glazing on radiant heat and thermal comfort for on-road conditions.* Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 24 p. Sponsor: Michigan University, Ann Arbor, Industry Affiliation Program for Human Factors in Transportation Safety. Report No. UMTRI-2004-40.

Eby, D.W.; Vivoda, J.M. 2004. *Direct observation of safety belt use in Michigan: Fall 2004.* Michigan University, Ann Arbor, Transportation Research Institute, Social and Behavioral Analysis Division. 69 p. Sponsor: Michigan Office of Highway Safety Planning, Lansing. Report No. UMTRI-2004-36.

Sivak, M.; Schoettle, B.; Minoda, T.; Flannagan, M.J. 2005. *Blue content of LED headlamps and discomfort glare.* Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 22 p. Sponsor: Michigan University, Ann Arbor, Industry Affiliation Program for Human Factors in Transportation Safety. Report No. UMTRI-2005-2.

Tsimhoni, O.; Bärgman, J.; Minoda, T.; Flannagan, M.J. 2004. *Pedestrian detection with near and far infrared night vision enhancement.* Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 26 p. Sponsor: Michigan University, Ann Arbor, Industry Affiliation Program for Human Factors in Transportation Safety. Report No. UMTRI-2004-38.

Wetzel, J.M.; Sayer, J.R.; Funkhouser, D. 2004. *An examination of naturalistic windshield wiper usage.* Michigan University, Ann Arbor, Transportation Research Institute, Human Factors Division. 21 p. Sponsor: Michigan University, Ann Arbor, Industry Affiliation Program for Human Factors in Transportation Safety. Report No. UMTRI-2004-35. RR

Conferences & Events

TRB 85th Annual Meeting
January 22–26, Washington, D.C.
www.trb.org/meeting

Fourth World Mobility Forum
January 31, Stuttgart, Germany
www.worldmobilityforum.com

Wireless Technology for Trucking
February 7–8, Miami, Florida
www.eyefortransport.com/wirelesstruck06

Finnish Winter Road Congress
February 15–16, Jyv?skyl?, Finland
www.tieyhdistys.fi

Road Safety & Traffic Management
February 15–16, Cairo, Egypt
www.trafficegypt.com/en/index.asp

Michigan Truck Expo and Safety Symposium
February 21–22, Lansing, Michigan
www.truckingsafety.org/Seminars/expo.htm

71st Road Safety Congress
February 27 – March 1, Blackpool, England
www.rospa.org.uk/road

Michigan Traffic Safety Summit
February 28–March 1, Lansing, Michigan
http://tinyurl.com/9edye

Lifesavers 2006: National Conference on Highway Safety Priorities
March 9–11, Austin, Texas
www.lifesaversconference.org

Workshop on Intelligent Transportation
March 14–15, Hamburg, Germany
wit.tu-harburg.de

World of Asphalt 2006
March 14–16, Orlando, Florida
www.worldofasphalt.com

Transportation and University Communities
March 18–21, East Lansing, Michigan
www.apta.com/conferences_calendar/univ

ITE 2006: Transportation Solutions for the Real World
March 19–22, San Antonio, Texas
www.ite.org/meetcon

GIS-T 2006: GIS for Transportation
March 27–29, Columbus, Ohio
www.gis-t.org

PIARC International Winter Road Congress
March 27–30, Turin and Sestriere, Italy
www.aipcr2006.it

Purdue University Road School
March 28–30, West Lafayette, Indiana
http://rebar.ecn.purdue.edu/JTRP

National Conference on Transportation and Economic Development
March 29–31, Little Rock, Arkansas
www.ted2006-littlerock.org

SAE 2006 World Congress
April 3–6, Detroit, Michigan
www.sae.org/congress RR

To Subscribe to the *UMTRI Research Review*...

Complete the form below and send it with a check for $35 made out to the University of Michigan. This entitles you to a one-year subscription to the *UMTRI Research Review*.

NAME DATE ______________________

TITLE ______________________ ORGANIZATION ______________________

ADDRESS ____

CITY______________________ STATE ______________ ZIP______________
include +4

Mail your check for $35 and the form above to:

• Monica Milla, Editor • UMTRI Research Review • University of Michigan Transportation Research Institute •

Transportation Tidbits

- On February 1, 1898, the Travelers Insurance Company of Hartford, Connecticut, was the first company to issue an automobile insurance policy to an individual. Dr. Truman J. Martin of Buffalo, New York, paid a premium of $11.25, which covered $5,000 to $10,000 of liability. In 1925, Massachusetts became the first state to mandate automobile insurance.
- The first car advertisement to run in a national magazine appeared in the *Saturday Evening Post* on March 31, 1900. The W.E. Roach Company of Philadelphia ran an ad featuring its jingle, "Automobiles That Give Satisfaction."
- On March 17, 1914, the Fifth Avenue Coach Company of New York introduced the first bus with cross-wise seats. Prior to this, all buses had been equipped with longitudinal seating. Cross seats allowed passengers to face forward, affording them a less one-sided view of their world. The company's double-decker buses were capable of seating 44 passengers.
- Safety glass in windshields became mandatory in Great Britain on January 1, 1937. In early automobile accidents, ordinary glass windows often turned into large, deadly blades. The most common type of safety glass is a sandwich in which a layer of clear, flexible plastic is bonded between two layers of glass. It was first produced in 1909 by French chemist Edouard Benedictus, who used a sheet of clear celluloid between glass layers. Various plastics were tried over the years. In 1936, a plastic called polyvinyl butyral (PVB) was introduced. It was so safe and effective that it soon became the only plastic used in safety windows.
- On January 1, 1942, The U.S. Office of Production Management prohibited sales of new cars and trucks to civilians. All automakers dedicated their plants entirely to the war effort. By the end of the month, domestic car manufacture had stopped. Automobile plants were converted wholesale to the manufacture of bombers, jeeps, military trucks, etc.
- Leaded gasoline went on sale for the first time on February 2, 1923. The gasoline, mixed with tetraethyl lead, was sold to the public at a roadside gas station owned by Willard Talbott in Dayton, Ohio. Coined "ethyl gasoline" by Charles Kettering of General Motors, the blend was discovered by General Motors laboratory technician Thomas Midgley to beneficially alter the combustion rate of gasoline. In seven years of research and development, GM labs tested about 33,000 compounds for their propensity to reduce knocks. Leaded gasoline would fill the world's gas tanks until emissions concerns lead to the invention of unleaded gasoline. RR

SOURCE: This Day in Automotive History, www.historychannel.com/tdih

UMTRI
UNIVERSITY OF MICHIGAN
TRANSPORTATION RESEARCH INSTITUTE

2901 Baxter Rd
Ann Arbor MI 48109-2150

Non-Profit Organization
U.S. Postage
PAID
Ann Arbor, MI
Permit No. 144