

## TECHNICAL NOTE

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### The Identification of Domestic and Foreign Automobile Manufacturers Through Body Primer Characterization

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**ABSTRACT:** Primer layers of domestic and foreign automobiles were studied according to color and layer sequences used by the various manufacturers. This was achieved by collecting paint samples, sanding them, examining them under a stereomicroscope, and performing various spot tests. The data were tabularized and grouped according to color and layer sequences. This method is expected to aid in the identification of many automobiles.

**KEYWORDS:** forensic science, automobiles, paints, primer, color

Identification of automobile paint transferred to victims of hit-and-run accidents is one of the many tasks that a forensic scientist encounters in the crime laboratory. This task has become more difficult because of the intense competition in the past few years by the automotive manufacturers worldwide for the best rust-protected cars. This necessitated the most advanced coatings technology and, as a result, induced changes in the body primer composition and layer structure. A switch from anodic to cathodic electro-deposition [1] allows more penetration and more control over the thickness of the layer deposited and thus makes possible the elimination of a second primer layer. This technology has been adopted by the Chrysler Corporation. The changing technology of the top coats has also effected changes in base coating. The application of a clear coat as a top finish to produce more luster, a trend started by the Japanese and now used by many American and European manufacturers, tends to reduce the thickness of the base coats.

Information on the top coat and its chemical composition is well documented for domestic automobiles. Excellent reference standards can be obtained from the Collaborative Testing Service (CTS). The documentation is facilitated by the consistency and good quality control of the few American automotive paint manufacturers in meeting their customers' color and composition specifications. On the other hand, very little

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information is available on the foreign automotive paint manufacturers and how consistent they are in their paint production.

Information on paint primers for either domestic or foreign automobiles, however, has not been as extensive or available as it is on top coats. This project examined those paint primers used by automobile manufacturers between 1977 and 1988.

### Materials and Methods

Approximately 1100 samples of original automobile paints (1977–1988) were collected from salvage yards, automobile dealers, and private body shops. Only 850 samples were usable. The remaining 250 samples were unsuitable because of previous body work.

Traditionally, paint samples have been collected by scraping the vehicle paint with a scalpel or sharp utensil. This method poses three significant problems. First, when scraping the paint, not all layers of primer undercoating are obtained. There is a chance of removing the topcoat/primer layer excluding the primer/steel, thereby producing faulty sequencing data. Second, by scraping, one cannot determine whether the primer sequence is original paint or a repaint. (A sequence is considered original if the primer/steel layer has the "orange peel" texture characteristic of original paint primers.) Whenever original and repaint layers cannot be distinguished, the danger exists for producing faulty data. Third, the samples obtained by scraping may be too small for analysis or sequencing. A paint chip of sufficient size, layer sequence, and quality must be obtained for proper observation and sequencing.

A new technique has been developed to solve these problems. It was noticed that vehicles with dented or gouged regions produce large paint chips ranging from 1 to 3 cm<sup>2</sup> in size. Just by bending the metal, large pieces of paint, primer, and all, will peel intact. By this observation, all the person sampling the paint has to do is cut a small piece of metal from the vehicle using tin snips, bend the metal back and forth with pliers, and remove the paint chip intact. The technique also allows the collection of original primers even though a vehicle has been repainted, provided that the original primers have not been sanded away before repainting.

Once a sample has been removed from a vehicle, it is then placed in a container. The container should be sealed tightly to prevent loss of sample. Small Labelstik<sup>®</sup> cans with labels can be used. (Note: body region from where sample is taken should be recorded.) The make and model of each automobile is recorded and its year determined using the Vehicle Identification Number (VIN) plate.

VIN plates are located on top of the left dash or left windshield post, visible through the windshield. Starting in 1980, all vehicles, domestic and foreign, adopted a common system for year identification using the VIN plate. The system consists of different letters, each representing different years:

<i>Letter</i>	<i>Year</i>
A . . . . .	1980
B . . . . .	1981
C . . . . .	1982
D . . . . .	1983
E . . . . .	1984
F . . . . .	1985
G . . . . .	1986
H . . . . .	1987
J . . . . .	1988

The National Automobile Theft Bureau (NATB) proceeded from H to J because the letter I could be confused with the number 1.

The letter indicating the year of the vehicle is located eight digits from the right on the VIN plate. For example:

digit

WPOAAO944DN455338

8th

D = 1983

For accuracy, however, a *NATB Passenger Vehicle Identification Manual* should be consulted. NATB manuals are published yearly and contain both domestic and foreign automobile listings [2].

In this study, all paint chips were examined at  $\times 60$  using a stereomicroscope. Each paint sample was sanded using 600-grit sandpaper simply by placing the finger on the chip and rubbing it. This method helped to reveal all the layer sequences of the paint chip regardless of the thickness or number of the primer layers. For example, the 1986 Volvo 240 GL has four primer layers that are impossible to see by viewing at the cross section. However, when sanded, thinly sandwiched primer layers can be revealed.

Each primer color combination was noted and coded numerically to the NBS color charts. The color charts helped to give reference to the color named for each layer [3]. The number was documented for an easy search of the shade of the color desired. However, note that some shades of color are very similar and thus might be viewed differently by other examiners. Therefore, this color code should be used as a guide rather than to determine an exact color match.

Spot tests were performed on approximately 100 samples to determine whether their use would be of any value in primer comparisons. The reagents and solvents used were: (1) methyl ethyl ketone (MEK), (2) diphenylamine (DPA), (3) sulfuric acid, and (4) chloroform.

## Results and Discussion

In general, the spot tests proved to be futile. On occasion, the MEK would dissolve the acrylic lacquer top coats of General Motors paints, revealing the primer immediately underneath. However, certain General Motors models are no longer using the acrylic lacquer paints, and therefore, their top layer paint did not dissolve. For example, paint from 1983 and 1985 Chevrolet Camaros did not dissolve in MEK.

The first color of each sequence represents the primer layer directly under the top coat. The NBS color and layer sequences, together with their corresponding color numbers, were tabulated in an ascending numerical order. The single layers were listed first, followed by the double layers, and so on. The hyphenated listings denoted that the color match was somewhere in between the two choices. The make and model of the automobile using such sequences were listed, as shown in Table 1.

The large number of different colors used by the foreign automobile manufacturers is obvious. This can be attributed to the larger number of paint suppliers available to those automobile manufacturers. Some of the primer colors noted were unique to the foreign automobile manufacturers as seen in Table 2. Those colors with "no" in the "Foreign Restricted" column in Table 2 were used by domestic manufacturers also.

TABLE 1—*Make and model of automobiles using NBS sequences.*

Color Name and Number (NBS)	Used on (Make and Model)
Light olive gray 112	1983 Chrysler New Yorker  1984 Dodge Aries 1984 Dodge Daytona 1985 Plymouth Caravelle 1981–83 Plymouth Horizon 1983 Plymouth Turismo
Light olive gray-medium gray 112–265	1986 Chevrolet Celebrity 1986 Oldsmobile Cutlass Supreme 1985 Oldsmobile 98 Regency
Olive gray 113	1982 Dodge Aries 1984 Dodge Charger 1984 Dodge 600 ES 1983, 84 Plymouth Reliant
Light blue gray 190	1984 Honda Accord
Blue gray 191	1985 Buick Century 1988 Buick Regal 1985 Buick Skylark 1987 Chevrolet Astrovan 1978–81 Honda Accord 1987, 88 Chevrolet Baretta 1987, 88 Chevrolet Camaro 1986 Chevrolet Caprice 1986, 88 Oldsmobile Cutlass Calais 1985 Oldsmobile Firenza 1987 Oldsmobile Delta 88 1986, 88 Pontiac Grand Am 1987 Ford Bronco 1981, 86, 87 Dodge Charger 1980 Dodge Colt 1984, 85 Plymouth Horizon 1984, 85 Plymouth Reliant
Dark blue gray 192	1978 Chrysler Le Baron 1984 Chrysler New Yorker 1986 Ford Mustang
Light gray 264	1985 Nissan Stanza
Medium gray 265	1980–82 Honda Prelude
Black 267	1985 Chevrolet Camaro 1986 Chevrolet Silverado 1981 Dodge Aries 1978, 79 Dodge Diplomat 1982, 84 Chrysler LeBaron 1979 Dodge Omni 1979 Plymouth Valare 1980 Plymouth Horizon 1981, 82 Plymouth Reliant

TABLE 1—Continued.

Color Name and Number (NBS)	Used on (Make and Model)
Light red brown/dark green gray 42/156	1985 Ford EXP 1981 Ford Granada 1982 Ford LN7 1983, 84 Ford LTD 1981–85 Ford Mustang 1978 Lincoln 1981 Mercury Capri 1979, 82, 83 Mercury Cougar 1982–85 Mercury Lynx
Light red brown/black 42/267	1979 Ford Fairmont 1979–81 Ford Thunderbird 1979–81 Mercury Marquis
Light gray red brown/ dark green gray 45/156	1981–87 Ford Escort 1984 Ford LTD 1985–88 Ford Taurus 1984 Ford Tempo 1986 Mercury Topaz
Light gray red brown/ green gray-black 45/156–267	1981, 82 Ford Fairmont
Light gray red brown/ dark blue gray 45/192	1987 Ford Aerostar
Light gray red brown/black 45/267	1983 AMC Concord 1980 Ford Fairmont 1980 Ford Futura 1977, 79 Ford Granada 1979 Ford LTD 1979, 80 Ford Mustang 1980 Mercury Capri 1983 Renault Alliance
Gray red brown/medium gray 46/265	1980 Subaru Brat
Dark gray red brown/ green gray 47/155	1979 Datsun 310
Dark gray brown/light gray 62/264	1986 Mercedes-Benz 190E
Light brown gray/black 63/267	1984 Renault Encore
Light gray yellow brown/ black 79/267	1980 Cadillac Fleetwood
Pale yellow/medium gray 89/265	1985 Nissan Sentra
Yellow white/light olive gray 92/112	1980, 81, 83, 84 Volkswagen Rabbit
Yellow gray/blue gray 93/267	1985 Oldsmobile Delta 88 1985 Oldsmobile 98
Yellow gray/black 93/267	1983 Chevrolet Celebrity

TABLE 1—Continued.

Color Name and Number (NBS)	Used on (Make and Model)
Light olive gray/blue gray 112/191	1984 Buick Skyhawk 1985–87 Chevrolet Cavalier 1987 Oldsmobile Cutlass Cierra 1981 Oldsmobile Cutlass Supreme 1986 Pontiac Sunbird
Light olive gray/black 112/267	1982 Buick Century 1983 Buick Skyhawk 1981–83 Buick Skylark 1981 Cadillac DeVille 1982 Chevrolet Celebrity 1983, 84, 86 Chevrolet Chevette 1981, 83 Oldsmobile Cutlass Cierra 1987 Oldsmobile Toronado 1987 Pontiac Firebird 1981, 84 Pontiac 1000 1983 Pontiac 2000 1982, 86 Pontiac 6000
Olive gray/black 113/267	1984 Renault Alliance
Pale yellow green/blue gray 121/191	1986 Dodge Daytona 1987 Oldsmobile Cutlass Cierra 1988 Pontiac LeMans
Green gray/blue gray 155/191	1985 Chevrolet Celebrity
Light blue gray/medium red brown 190/43	1978, 79 Toyota Celica 1979 Toyota Cressida
Light blue gray/gray red brown 190/46	1981 Renault LeCar
Light blue gray/yellow gray 190/93	1985 Honda Civic
Light blue gray/light olive gray 190/112	1985 BMW 318i 1978 BMW 320i 1985 BMW 325 1988 Hyundai Excel 1978 Mazda RX-7 1986 Nissan Maxima 1979–83 Toyota Corolla 1977–79 Volkswagen Rabbit
Light blue gray/olive gray 190/113	1978 Honda Civic 1983, 86 Nissan Pulsar 1983 Nissan Stanza 1984 Nissan 200SX 1984 Toyota Camry 1980, 86 Toyota Celica 1979 Toyota Corona 1983 Toyota Tercel 1987 Mazda 323LX 1987 Mazda B2000

TABLE 1—Continued.

Color Name and Number (NBS)	Used on (Make and Model)
Light blue gray/green gray 190/155	1986 Dodge Colt 1984 Subaru GL
Light blue gray/dark green gray 190/156	1980–82, 84 Mazda 626 1985 Mitsubishi Mirzae
Light blue gray/blue gray 190/191	1985 BMW 325 1985 BMW 528e 1983, 86, 87 Honda Accord LXi 1986, 87 Honda Civic 1984, 87 Mitsubishi Starion 1987 Mitsubishi Mirage
Light blue gray/medium gray 190/265	1977 Porsche 924 1988 Yugo GV 1983 Isuzu Impulse
Light blue gray/dark blue gray 190/192	1980, 81 Datsun 310 GX 1984 Toyota Celica
Light blue gray/medium gray- dark gray 190/265–266	1983 Porsche 944
Light blue gray/dark gray 190/266	1984 Mazda GLC 1981, 84 Mazda RX7 1984 Subaru Turbo
Light blue gray/black 190/267	1981, 83 Audi 5000S 1980–82 Datsun 200SX 1978–81 Datsun 210 1981 Fiat Strada 1978–80 Mazda GLC 1982, 83 Renault LeCar
Blue gray/light gray yellow brown 191/79	1982–84 Honda Civic
Blue gray/yellow gray 191/93	1985 Chevrolet Beauville Van
Blue gray/light olive gray 191/112	1983, 84 Mitsubishi Cordia 1983, 84 Mitsubishi Tredia 1984 Chevrolet Cavalier
Blue gray/olive gray 191/113	1987 Nissan 300ZX 1977 Volkswagen Dasher
Blue gray/dark green gray 191/156	1979 Fiat Strada
Blue gray/medium gray 191/265	1986 Chevrolet Spectrum 1986 Dodge Colt 1980, 81 Oldsmobile Cutlass Supreme 1981 Plymouth Champ 1981 Plymouth Sapporo
Blue gray/black 191/267	1979, 80 Chevrolet Impala 1987, 88 Chevrolet S-10 1979, 81 Ford Fiesta 1982 Nissan Sentra

TABLE 1—Continued.

Color Name and Number (NBS)	Used on (Make and Model)
Dark blue gray/light gray olive 192/109	1978 Datsun 510
Dark blue gray/light olive gray 192/112	1978 Subaru GF
Dark blue gray/light blue gray 192/190	1985 BMW 735I
White/light olive gray 263/112	1980 Volkswagen Dasher
White/light blue gray 263/190	1985 Mercedes-Benz 500 SEL
White/dark blue gray 263/192	1986 Volkswagen GTI
Light gray/light olive gray 264/112	1980 Audi 4000
Light gray/olive gray 264/113	1978 Saab 900 1986 Toyota Camry
Light gray/blue gray 264/191	1985 Buick Park Avenue
Medium gray/greenish black 265/157	1979–82 AMC Concord 1983 Audi GT
Medium gray/blue gray 265/191	1987 Buick Century 1985–87 Chevrolet Nova 1984 Oldsmobile Cutlass Cierra 1985 Pontiac Grand Prix
Medium gray/black 265/267	1981–83 AMC Spirit, AMC Eagle 1978, 81, 83, 84 Buick Century 1978 Buick Electra 1985 Buick Riviera 1980 Buick Skylark 1979–83 Buick Regal 1979 Cadillac DeVille 1985, 88 Chevrolet Blazer 1978–83 Chevrolet Camaro 1979, 80, 84, 86 Chevrolet Caprice 1983, 84 Chevrolet Celebrity 1978, 80, 81, 82 Chevrolet Chevette 1980–84 Chevrolet Citation 1978, 80 Chevrolet Malibu 1980, 82, 85, 87 Chevrolet Monte Carlo 1978, 79, 82, 84 Oldsmobile Cutlass Supreme 1981, 82, 85, 87 Oldsmobile Delta 88 1981 Oldsmobile Omega 1979, 81, 85 Oldsmobile 98 Regency



TABLE 1—Continued.

Color Name and Number (NBS)	Used on (Make and Model)
	1979, 87 Oldsmobile Toronado
	1982 Renault Fuego
	1981 Pontiac Bonneville
	1980 Pontiac Grand Prix
	1980–82 Pontiac LeMans
	1980–82 Pontiac Phoenix
	1980 Pontiac Sunbird
	1979, 81, 82 Pontiac Trans Am
	1983–85 Pontiac 6000
Dark red/light blue gray/ dark gray 16/190/266	1983 Isuzu I-Mark
Dark gray brown/green gray/light blue gray 62/155/190	1985 Mercedes-Benz 380SE
Light brown gray/light blue gray light olive gray 63/190/112	1978 Volvo 242 GT
Light gray yellow brown/green gray/black 79/155/267	1983 Mercedes-Benz 240D
Yellow gray/green gray/black 93/155/267	1984 Mercedes-Benz 300SD
Light blue gray/blue gray/ black 190/191/267	1983 Nissan Sentra
Light blue gray/dark blue gray/ light olive gray 190/192/112	1987 Mitsubishi Precis
Light blue gray/pale yellow pink- light green gray/dark green gray 190/31–264/156	1986 Saab 9000
Blue gray/light blue gray/olive 191/190/113	1978 Datsun 210 1978 Datsun 310 GX
Blue gray/light blue gray/black 191/190/267	1980 Subaru 1600 DL
Dark blue gray/light blue gray/ light olive gray 192/190/112	1982 Nissan Stanza
Medium gray/light green gray/ blue gray 265/154/191	1987 Volvo 760
Dark gray/medium gray/dark gray 266/265/266	1982 Nissan Maxima
Light gray red brown/light olive gray/gray red brown/medium gray 45/112/46/265	1986 Volvo 240 GL
Brown pink/light blue gray/dark red gray/blue white/gray yellow 33/190/23/189/90	1978 Volvo 242 DL

TABLE 2—Unique colors (foreign).

Color	Year	Make	Model	Foreign Restricted
16	1983	Isuzu	I-Mark	Yes
23	1978	Volvo	242DL	Yes
31	1986	Saab	9000	Yes
33	1978	Volvo	242DL	Yes
43	1979	Toyota	Celica/Cressida	Yes
47	1978	Toyota	GT	Yes
	1979	Datsun	310	Yes
62	1986	Mercedes-Benz	190E	Yes
	1985	Mercedes-Benz	380SE	Yes
79	1982	Honda	Civic	No
	1984	Honda	Civic	No
	1983	Mercedes-Benz	240D	No
89	1985	Nissan	Sentra	Yes
90	1978	Volvo	242DL	Yes
	1980	Volkswagen	Rabbit	Yes
	1983	Volkswagen	Rabbit	Yes
92	1981	Volkswagen	Truck	Yes
93	1984	Mercedes-Benz	300SD	No
109	1985	BMW	318i	Yes
	1978	Datsun	510	Yes
142	1978	Volvo	242DL	Yes
184	1980	Volkswagen	Rabbit	Yes
189	1978	Volvo	242DL	Yes
263	1982	Renault	LeCar	Yes
	1985	Mercedes-Benz	500SEL	Yes
	1980	Volkswagen	Dasher	Yes
	1984	Volkswagen	Rabbit	Yes

## Conclusion

Considering the large number of foreign and domestic automobiles on the road, the task of cataloguing primers is by no means complete. Thousands of samples are needed for more comprehensive information. Only through further research can this task be completed.

## Acknowledgments

The contributions of John Marcouiller and Ronald McCoy are greatly appreciated.

## References

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- [2] National Automobile Theft Bureau, *1988 Passenger Vehicle Identification Manual*, New York, 1988.
- [3] National Bureau of Standards, *ISSC-NBS Color-Name Charts Illustrated with Centroid Colors*, 1964. (Charts can be purchased @ \$38.00 each from: The National Institute of Standards and Technology, Chemistry Bldg., Rm. B311, Gaithersburg, MD 20899.)

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