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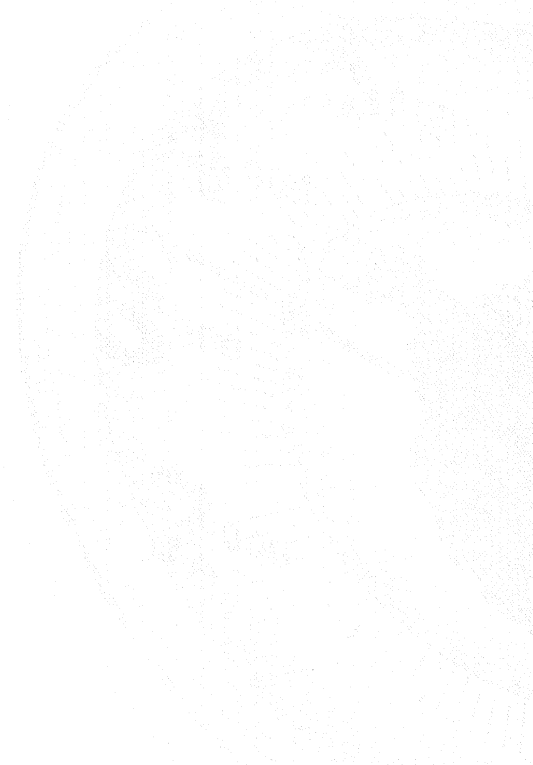
Office for the Study of Automotive Transportation
University of Michigan Transportation Research Institute

AUTOMOTIVE INTERIORS

DELPHI

Forecast
and
Analysis of the

NORTH AMERICAN AUTOMOTIVE MARKET



Strategic Planning Factors

Safety Issues

Technology/Electrical/Electronics

Materials

Global Issues



Admin

Automotive Interiors Delphi Forecast and Analysis
of the
North American Automotive Industry

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FOREWORD

Introduction

Automotive Interiors Delphi is a detailed analysis of forecasts of automotive industry executives, directors, managers and engineers who are expert in the automotive interiors sector. These individuals were selected because they occupy positions of responsibility within the automotive industry and have strategic insight into important industry trends. In many cases they are in a position to influence these trends.

The Office for the Study of Automotive Transportation (OSAT) collects the data and analyzes, interprets, and presents the results. Since the forecasts are those of the panelists, Automotive Interiors Delphi is essentially the industry's own consensus forecast. This forecast is not a "crystal ball" prediction but, rather, well-informed estimates, perspectives and opinions. Such forecasts present an important basis for business decisions and provide valuable strategic planning information for those involved in all areas of the North American automotive interiors sector.

A key point to keep in mind is that the Delphi forecast presents a vision of the future. It obviously is not a precise statement of the future but rather what the industry thinks the future will likely be.

The Delphi method: general background

The study is based on the Delphi forecasting process. This process requires that experts consider the issues under investigation and make predictions about future developments. Developed by the Rand Corporation for the U.S. Air Force in the late 1960s, Delphi is a systematic, interactive method of forecasting based on independent inputs regarding future events.

The Delphi method is dependent upon the judgment of knowledgeable experts. This is a particular strength because, in addition to quantitative factors, predictions that require policy decision are influenced by personal preferences and expectations. Delphi forecasts reflect these personal factors. The respondents whose opinions are represented in this report are often in a position to influence events and, thus, make their forecasts come true. Even if subsequent events result in a change of direction of a particular forecast, this does not negate the utility of the Delphi. This report's primary objective is to present the direction of technological, materials and marketing developments within the industry, and to analyze potential strategic importance.

Process

The Delphi method utilizes repeated rounds of questioning, including feedback of earlier-round responses, to take advantage of group input while avoiding the biasing effects possible in face-to-face panel deliberations. Some of those biasing effects are discussed in this excerpt from a 1969 Rand memorandum:

The traditional way of pooling individual opinions is by face-to-face decisions. Numerous studies by psychologists in the past two decades have demonstrated some serious difficulties with face-to-face interaction. Among the most serious are: (1) Influence, for example, by the person who talks the most. There is very little correlation between pressure of speech and knowledge. (2) Noise. By noise is not meant auditory level (although in some face-to-face situations this may be serious enough) but semantic noise. Much of the "communication" in a discussion group has to do with individual and group interest, not with problem solving. This kind of communication, although it may appear problem-oriented, is often irrelevant or biasing. (3) Group pressure for conformity. In experiments at Rand and elsewhere, it has turned out that, after face-to-face

discussions, more often than not the group response is less accurate than a simple median of individual estimates without discussion (see N. C. Dalkey, The Delphi Opinion. Memo RM 5888 PR, p. 14, Rand Corp., 1969).

In the Delphi method, panelists respond anonymously, preventing the identification of a specific opinion with any individual or company. This anonymity also provides the comfort of confidentiality, allowing panelists to freely express their opinions. Among other advantages, this process enables respondents to revise a previous opinion after reviewing new information submitted by other panelists. All participants are encouraged to comment on their own forecasts and on the combined panel results. The information is then furnished to the panel participants in successive iterations. This procedure reduces the effects of personal agendas or biases and assists the panelists in remaining focused on the questions, issues and comments at hand.

Panel characteristics and composition

The very essence of a Delphi survey is the careful selection of expert respondents. The selection of such experts for this Delphi survey is made possible by the long-standing association between The University of Michigan's Office for the Study of Automotive Transportation and representatives of the automotive industry. A list of prospective experts was assembled for the Interiors panel. Members were selected on the basis of the position they occupy within the automotive industry and their knowledge of the topic being surveyed. They are deeply knowledgeable and broadly experienced in the subject matter.

The names of the panel members and their replies are known only to our office and are maintained in the strictest confidence. Replies are coded to ensure anonymity. The identity of panel members is not revealed. Upon publication of the final Delphi report, all questionnaires and lists of panelists are destroyed.

The characteristics of the respondents are as follows: 39 percent of the panelists were CEOs, presidents, or vice presidents; 24 percent were directors; 24 percent were executives, managers or supervisors; 13 percent were engineers (chief, assistant chief and staff). In total, 59 individuals participated in the survey process.

Presentation of Delphi forecasts and analyses

Data tables. When a question calls for a response in the form of a number, responses are reported as the median value and the interquartile range (IQR). The median is a measure of central tendency that mathematically summarizes an array of judgmental opinions while discounting extremely high or low estimates; it is simply the middle response. The IQR is the range bounded at the low end by the 25th-percentile value, and at the high end by the 75th-percentile value. For example, in a question calling for a percentage forecast, the median answer might be 40 percent and the IQR 35-45 percent. This means that one-quarter of the respondents answered 35 percent or less, another one-quarter chose 45 percent or more, and the middle half of all responses ranged between 36 percent and 44 percent, with 40 percent as the middle response. That narrow interquartile range would indicate a fairly close consensus among the respondents.

In contrast, the percentage forecast for a different question might show a similar median forecast of 40 percent, but with an interquartile range of 20-70 percent, indicating less consensus and a considerable degree of uncertainty about the issue in question.

Uncovering differences of opinion is one of the major strengths of the Delphi method. Unlike other survey methods, where differences of opinion among experts are often obscured by statistical averages, the Delphi highlights such differences through the presentation of the interquartile range.

Discussion. Narrative discussions are presented to highlight and explain a particular set of data.

Selected edited comments. Selected edited comments from the Delphi panelists are shown following each data table in order to provide some insight into the deliberative process by which panelists arrived at their forecast.

In a Delphi survey, respondents are encouraged to contribute comments to explain their forecast and to perhaps persuade other respondents to change their positions. Many of these edited comments are included. These replies may provide important information which is not evident in the numerical data. An individual panelist may have unique knowledge that planners should carefully consider. However, readers should be careful not to overemphasize a particular comment. It is possible for a well-stated contrary opinion to mislead the reader into ignoring an important majority opinion which is accurately reflected in numerical data.

Strategic considerations. Based on the replies to a particular question, other relevant Automotive Interiors Delphi forecasts, other research and studies, and OSAT's extensive interaction with the automotive industry, this report makes inferences and interpretations as to the core issues in questions and their potential impact on the industry. By no means are they exhaustive statements of critical issues. Rather, they are points that the reader might consider useful.

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EXECUTIVE SUMMARY

The North American automotive industry stakeholders face a decade of challenge and change. Nowhere is that change more visible than in the automotive interiors sector, especially with regard to systems integration. The *Automotive Interiors Delphi Forecast and Analysis of the North American Automotive Industry* identifies many of the challenges and opportunities facing industry participants. In doing so, this study presents an opportunity for companies to benchmark their vision of the future with that of an industry consensus.

The *Automotive Interiors Delphi* is divided into five sections addressing Strategic Planning Factors, Safety Issues, Technology/Electrical/Electronics, Materials and Global Issues. This summary is intended to highlight key results from the Interiors Delphi Panel.

I. STRATEGIC PLANNING FACTORS

As companies, both assemblers and system integrators, strive to gain brand recognition, the interior is certain to become a focal point. Design, technology and product differentiation will play a major role in developing unique cockpit themes. The cockpit module and all of its components represent an important driver/passenger vehicle interface, and are therefore critical to customer satisfaction.

Panelists forecast the cockpit module to offer the greatest opportunity for product differentiation in the coming decade. Instrumentation, collision warning systems, and navigation systems are also forecast to offer excellent opportunities for product differentiation. Conversely, carpet, convertible tops, and sunroofs are forecast to offer only moderate opportunity for differentiation.

According to the panel, quality/reliability/durability (QRD) and cost to the manufacturer are currently ranked as the most important elements of competition. However, the fact that the panel rates all listed elements as at least somewhat important is critical. Suppliers will be required to excel in all operational aspects—no easy task in an environment of severely constrained resources.

Scale economies present significant savings potential for automotive industry participants. Any part or component that is transparent to the consumer is a candidate for standardization. As assemblers move to consolidate vehicles to fewer platforms, so too must suppliers attempt to reduce the number of part designs. Panelists list a wide variety of components that are candidates for standardization. The components most frequently mentioned are safety systems, electrical systems, and intelligent transportation systems.

Interior styling presents one of the truly great avenues for product differentiation. The continued implementation of brand management may present an even greater impetus. The panelists list a wide variety of styling changes and themes for the coming decade. While styling cues for 2000 are already established, themes beyond 2000 are still in development.

The panelists' comments on future durability standards focus on buzzes/squeaks/rattle (BSR) and more stringent material requirements. Standards for these two areas, along with the others mentioned, are forecast to get increasingly severe. The effort to reduce buzzes/squeaks/rattles (BSR) is an excellent example of the potential gains to be made by well-executed systems engineering. The ability of a skilled systems integrator to design, engineer, and manage a program that results in a quiet, well-fitting interior system can become a competitive advantage for both the supplier and their customer.

Over the last decade, many key processes have undergone re-engineering in the North American automotive industry. Practices that traditionally governed the industry no longer apply. As companies struggle to define the future, no element of change has been more challenging and controversial than the supplier-assembler relationship.

The panel leaves little doubt that price is currently the most important purchase criteria for assemblers. They also rank delivery and quality as factors that are currently important. Industry

observers suggest that these three attributes may merely represent a ticket for entrance to the automotive industry.

The automotive interiors sector has experienced a significant shift to a systems integration strategy. Panelists list the ability to leverage suppliers' capabilities as the most common strategic consideration by vehicle manufacturers in their desire to increase system sourcing. Other issues of strategic consideration mentioned by the panelists include cost reduction and modularization.

There is probably no more divisive element of the assembler-supplier relationship than the issue of adequate evaluation and compensation. The perception of what is adequate compensation is often markedly different for the two parties. Panelists rate manufacturers' ability to evaluate programs as more adequate than their ability to adequately compensate for effort on the programs.

Panelists forecast that value added by vehicle manufacturers will decrease for all components/systems listed in the survey. Conversely they forecast increased value-added by interior system integrators, system suppliers and component suppliers. Engineering service providers are forecast to experience increased value-added in product engineering.

Panelists rated Chrysler as the most likely to source complete interior systems by 2000. General Motors, Honda, Nissan, and Subaru were rated as the least likely to source complete interior systems. Panelists do not expect interior system suppliers to gain brand awareness with the vehicle purchaser by 2000. However, 27 percent of the respondents do expect these companies to achieve brand awareness by 2005.

II. SAFETY ISSUES

Until recently, the increased application of airbags was considered a certainty. However, with reports of injuries and fatalities associated with airbag deployment, especially in the case of children and small adults, some doubt now exists. Penetration rates for side impact airbags is forecast to reach 28 percent for passenger cars and 20 percent for light trucks by 2005. Passenger side airbags are forecast to reach 100 percent for light trucks by 2005. Other listed airbag applications are forecast to remain at or below 10 percent by 2005.

Panelists listed changes in regulation/legislation and depowered airbags most frequently as the most effective strategy for protecting small adults and children from airbag deployment injuries.

III. TECHNOLOGY/ELECTRICAL/ELECTRONICS

The interior of a vehicle presents opportunity for increased options and features. However, cost remains a major barrier to the introduction of new features. Panelists forecast a wide variety of technologies to reach limited application in the coming decade. Most Intelligent Transportation Systems (ITS) technologies are not forecast to reach 25 percent application until 2010 and beyond.

Panelists forecast adjustable steering columns, anti-theft devices, keyless entry systems and CD players to gain significant increases in application rates for passenger cars by 2005. The same features are forecast to see growth in light trucks, but to a lesser degree. Car phones, dual climate control systems, incoming air filters, leather interiors, steering wheel-mounted controls, and trip computers are forecast to reach penetration rates of 25 percent or less for passenger cars and light trucks.

Multiplexed (MPX) power systems are forecast to experience significant penetration in the coming decade. The panelists forecast MPX power subsystem utilization in large/luxury cars to reach nearly 50 percent by 2005. However, the wide interquartile ranges indicate some uncertainty regarding the future of MPX systems. There is also substantial uncertainty regarding the cost effectiveness of fiber optic control busses for multiplexed system applications in

automobiles. Panelists forecast 15 percent of MPX systems will use fiber optic control bus techniques by 2005.

According to the panelists' forecast, analog instrumentation will remain the predominant display format in the coming decade. However, digital and electroluminescent instrumentation are forecast to see increased application.

Panelists present a wide variety of barriers to the acceptance of generic instrument port panels. Those barriers most frequently mentioned include standardization between vehicle manufacturers, bus communication protocol, and the ability of the manufacturers to control profits.

IV. MATERIALS

Panelists rate the cost of materials and the cost of processing as the most important material selection criteria currently, and in 2005. However, weight, presently rated as the fourth most important criteria, is forecast to be nearly as important as cost of materials and processing by 2005. Of the listed selection criteria, all except cost of materials and processing are rated as being more important in 2005 than currently.

The panel forecasts seat frames, instrument panel cross beams, skins and cores, door trim panels, and headliners to experience material usage changes in the coming decade. Conversely, the panelists forecast material choices, seat covers, carpet fiber, and carpet-backing materials to remain relatively unchanged. However, the wide interquartile ranges for materials on several components suggest that there is some disagreement or uncertainty regarding future materials for these components.

The panel forecasts as probable federal regulation/legislation regarding the disposal of tires, the disposal of automotive fluids, recyclability of plastics, and the uniform coding standards for materials by 2005.

Panelists responses include four basic elements of improved customer satisfaction associated with material advances in the coming decade. The panel expects quality/reliability/durability, fit and finish, ergonomics, and safety to all see significant improvement due to better materials and processes.

V. GLOBAL ISSUES

Suppliers of automotive interior systems and components face many challenges with regard to globalization. All automotive suppliers face operational, capital, and cultural barriers, yet interior suppliers also face the challenge of styling and design to meet the needs of unique local tastes. Panelists present a wide variety of challenges for the listed functions/activities with regard to implementation of a global strategy. The ability of a company to adapt to local markets and tastes, local versus centralized control, design flexibility, and limited capital resources are the most common themes presented.

A majority of the respondents (65 percent) expect globalization will affect systems suppliers differently than part and component suppliers. According to those that see a difference, systems integrators and suppliers will be required to have global capabilities, while part and component suppliers will be more likely to have regional requirements.

During the past decade, North American manufacturers have spent and are spending considerable effort and money to enter emerging markets. These new markets are often markedly different than the U.S. market, and a proven record of success in North America does not guarantee success in Southeast Asia or South America. Panelists most frequently list the ability to understand the customer as a unique challenge to entering emerging markets from a styling and product feature perspective. With respect to manufacturing, the panelists view the challenge of balancing capital resources as critical to entrance into emerging markets.

All components listed in the survey are rated as at least moderately likely to be globally sourced. However, panelists rate audio systems, instrumentation, interior lighting, and HVAC/radio controls as the components most likely to be globally sourced.

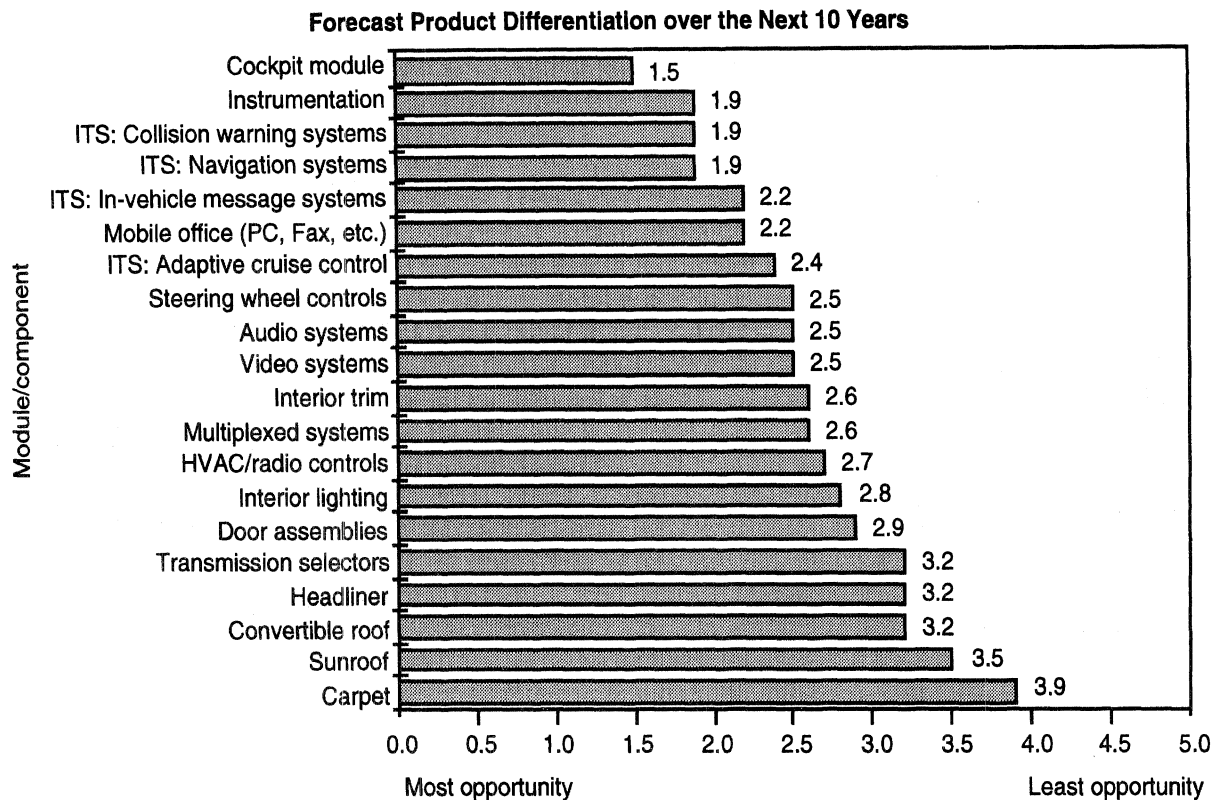
Conclusion

The panel has identified many opportunities and challenges for the automotive interiors industry. Throughout this survey, it is apparent that the rapid pace of change this sector has undergone in the last several years will continue. To be competitive in the coming decade, automotive interiors industry participants will need to develop proactive strategies that enable them to be prepared for those impending changes.

INT-1

What interior modules or components will offer the greatest opportunity for product differentiation over the next ten years (1996 - 2005).

Where 1 = most opportunity, 3 = moderate opportunity, and 5 = least opportunity.



Other Single Responses:

- Automatic toll collection: 2
- Emergency, life rescue: 1
- Ergonomics: 2
- Internet: 2
- Noise suppression: 1
- Reconfigurable display: 3

Selected edited comments

- ITS must be user-friendly, provide benefit in everyday driving situations and be reasonably priced in order to have a meaningful penetration in the market place. Otherwise, they'll just be interesting gadgets for a small number of technophiles and eventually go away like CRTs.
- Product definition will be driven by "creative features," especially in the United States and Japan.
- Remember, the theme for the next few years is occupant security.

Discussion

Panelists forecast the cockpit module (1.5) to offer the greatest opportunity for product differentiation in the coming decade. Instrumentation (1.9), collision warning systems (1.9), and navigation systems (1.9) are also forecast to offer excellent opportunities for product

differentiation. Conversely, carpet (3.9), convertible roofs (3.2), and sunroofs (3.5) are forecast to offer only moderate opportunity for differentiation.

Strategic considerations

As both assemblers and system integrators strive to gain brand recognition, the interior is certain to become a focal point. Design, technology, and product differentiation will play a major role in developing unique cockpit themes. The cockpit module represents an important driver/passenger vehicle interface; therefore it presents outstanding opportunity for product differentiation.

With the high ratings for instrumentation, it is clear that manufacturers will concentrate significant resources here. Advanced technologies such as reconfigurable flat-panel displays and other software-defined displays could offer the individual customer an opportunity to select their own instrumentation design.

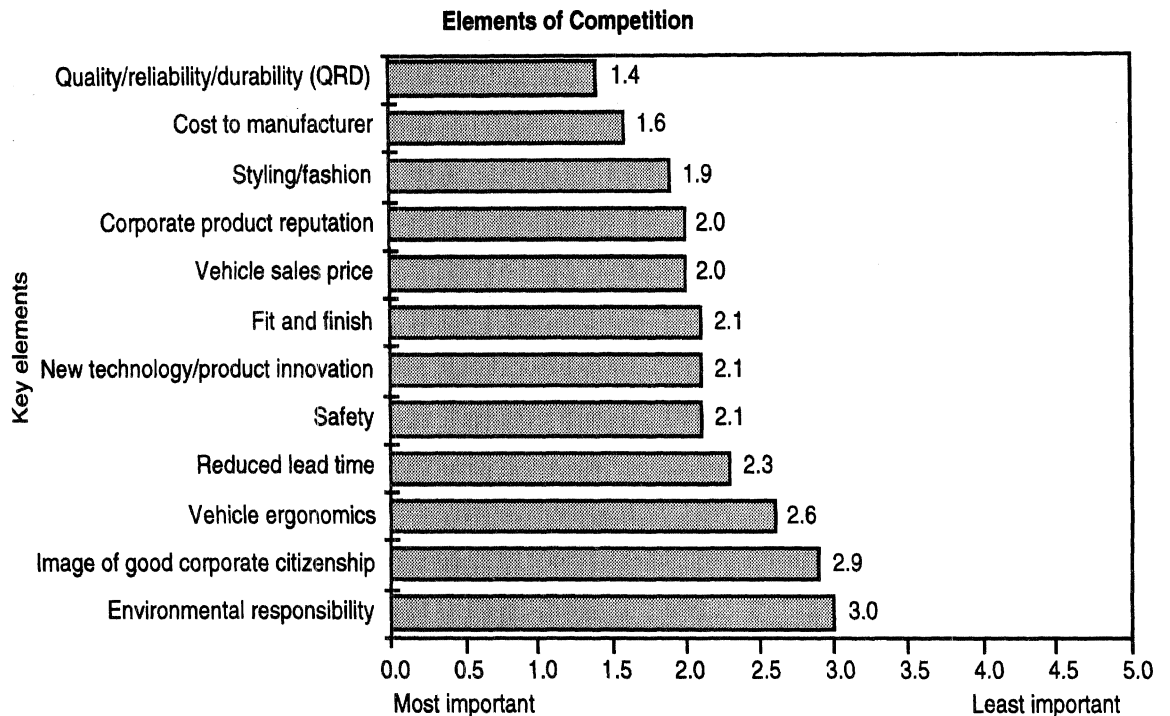
Intelligent transportation system technologies will become one of the key differentiators in the coming decade. Panelists rate all four ITS technologies as offering significant opportunity for differentiation. Critical to the success of a wide range of ITS technologies is the establishment of a standard ITS gateway.

Navigation systems, although only offered in limited regions and only on luxury vehicles in the U.S., have gained wider acceptance in Japan and in Europe. Because of litigation concerns, many ITS technologies will likely experience delayed penetration in the U.S. vis-à-vis Japan and Europe.

Electronics will be a powerful factor in providing differentiating opportunities in the automotive interior.

INT-2. How important are these elements of competition to the vehicle manufacturers currently?

Where 1 = most important, 3 = somewhat important, and 5 = least important.



Other Single Responses:

- Improved flexibility of the workforce: 1
- North American production: 3
- Performance: 3
- Union control: 1

Selected edited comments

- It's getting to the point where everything is important.
- People pay premiums for products with good residuals. They are easy to sell, easy to lease, but require a product to stand up without mechanical failure for over 100,000 miles. Good resale is the most meaningful "surprises and delight" a product can provide. It delivers loyalty and lasting customer satisfaction.
- Somehow vehicle prices continue to rise at 2-3% per year while suppliers are mandated to 4-5% annual cost reductions, and material suppliers continue to drive prices up. How about some OEM price reductions?

Discussion

The panel rated quality/reliability/durability (1.4) and cost (1.6) as the most important competitive elements. However, all of the listed elements were rated as at least somewhat important.

Strategic considerations

Quality/reliability/durability (QRD) and cost to the manufacturer are currently ranked as the most important elements of competition. However, the fact that the panel rates all listed elements as at least somewhat important is critical. Suppliers will be required to excel in all operational aspects—no easy task in an environment of severely constrained resources.

To further compound the challenge, industry participants are moving quickly to reduce lead time and bring products to market more efficiently. This attempt to compress time will increasingly magnify companies' strengths and weaknesses. Assemblers and suppliers that excel at systems engineering will likely gain significant advantages, while those that struggle with systems engineering will face an increasingly challenging period.

Maslow's hierarchy of needs, from psychology, is worth repeating here. From a person's view, air is the most basic need and if we lose air to breathe, everything else is unimportant. However, if we have air, we forget about its importance and focus on the next need on the list, water, and on through food, shelter, etc. This applies to vehicle attributes as well. As manufacturers reach parity in a high-priority need, the next attribute on the list becomes the differentiator.

INT-3. Considering the recent trend toward standardization by the vehicle manufacturers, what interior-related components do you anticipate will be standardized by 2005? *[Response categories provided: between companies, between platforms, between components.]*

Between companies:

- Bulbs
- Car communication system, sun roof, security system
- Carpet, switches, controls
- Electronics - busses
- Extent of product indifferntiation will dictate standardization of interior components.
- Fasteners
- Intelligent transportation systems - government involvement will help support standardization.
- Multiplex systems, non-competitive electrical components (e.g., cigarette lighters) and electrical connectors (USCAR)
- Multiplexed nodes and wiring terminators/connection systems
- Navigational systems, collision avoidance systems
- Platform offerings
- Child seats, brake application systems, controls such as shifters, cruise and headlights
- Safety restraint systems: seat belts, head impact foam
- Seat frames
- Seats and carpet, climate controls
- Side airbag protection (2)
- Very few, except among affiliates (Ford/Mazda, GM/Isuzu, BMW/Rover, Volvo/Mitsubishi, etc.). Steering columns/radio/CD players/switches.

Between platforms:

- A/C systems, particularly in medium-small vehicles
- Audio systems, multiplex systems
- Audio/climate control/carpet
- Cross platform solution will be standardized across many platforms. This standardization will be transparent to the vehicle buyer.
- Cruise control, carpet, seat belt gear chains
- Door locks, handles, door and window regulators and related mechanisms, substrate of trim components
- Fasteners, bolts, clips, screws, etc.; seats; steering wheels
- Fasteners, seat frames, HVAC components, lighting, convenience items (cup holders, etc.) glovebox hardware, steering wheels
- Glove boxes, steering column covers, speaker grilles, air outlets and grill consoles
- Instrumentation, audio systems
- Low visibility items
- Most nonvisible, nondifferentiable components such as seat frames, airbag modules, columns, etc.
- Multiplexing
- Overhead consoles, sun visors, instrument panels, seats
- Passenger side airbag systems, lumbar systems

- Seating, I/P and HVAC and radio
- Steering wheel controls
- Steering wheel, climate control controls, shift lever, seats
- Steering wheel/columns, radios, instrument clusters, features, switches
- Sunroofs
- Transmission selectors, adaptive cruise control, navigational systems, multiplexed systems, HVAC radio controls

Other single responses:

Restraints/Safety (3)

Airbags (4)

No standardization between companies (5)

Discussion

Panelists list a wide variety of components that are candidates for standardization. The most common types of components mentioned include safety systems, electrical systems, and intelligent transportation systems.

Strategic considerations

Scale economies present significant savings potential for automotive industry participants. Any part or component that is transparent to the consumer is a candidate for standardization. As assemblers move to consolidate vehicles to fewer platforms, so too must suppliers attempt to reduce the number of part designs. Where appropriate, suppliers will be asked to standardize components between platforms, and even between manufacturers. For proof that the industry is willing to look beyond the traditional company boundaries for savings through standardization, one need look no further than USCAR's effort to develop guidelines that will lead the industry to a common standard for electrical connectors.

The fact that the panel lists such a wide variety of components as potential standardization candidates suggests the impact that standardization will have on the industry. Certainly the interior is ripe with opportunity for cost savings through standardization. Safety systems, such as airbags and seat belts, intelligent transportation systems and a number of hidden components like seat tracks and window regulators, offer significant opportunity between platforms and even companies.

As assemblers move to standardize components, decisions will likely be made, not only on cost considerations, but also on the customers perceived value. In the past, as companies attempted to cut costs, badge engineering led to similar vehicles within corporations. Customers were often hard-pressed to find differences between these "badge-engineered" products. Component standardization must be accomplished without compromising product differentiation and uniqueness.

INT-4. What major *interior* styling changes do you anticipate by 2000 and 2005 (i.e., color, materials, harmonization, theme, personalization, etc.)? [Response categories provided: passenger cars, year 2000, 2005; light trucks, year 2000, 2005.]

Passenger Cars

2000:

- Continuation of softer more sculptured looks.
- Flow-through design of IP, doors, console; increased harmony among components; elimination of red colors; increased use of HUD's.
- Greater use of all belts to seat (i.e., seat integrated belts/shoulder harnesses).
- Harmonization
- Individual climate control modules for each passenger, rounded features.
- Integration of (personal) computing capability.
- Interactive interiors
- Lighter-colored interior surfaces, e.g., IP and other interior trim; 2-tone IP upper/lower, "softer" touch/feel surface materials
- Materials, improved technology on noise suppression
- More color and action, more pattern in broadcloth, more ergonomic comfort/more convenience
- More durable materials, less paint; probably TPO/TPE type chemistry; smart airbag sensing systems
- More modularization of controls, i.e., audio and climate control pod, continue earth tone colors
- More products designed for specific age groups
- No appreciable change.
- Personalization of electronic devices such as navigation, communication systems, etc. - some material changes.
- Simpler and commonized door trim, total harmony of color and materials
- Simplified interior instrumentation layout
- The interior will be integrated and color coordinated.

2005:

- Colors become brighter, more radical ultra fighter type cockpit designs, fighter grip steering
- Dashboard size reduction - more interior room
- Drive by wire, less conventional steering mechanisms
- Economically driven by aging population/less plastic wood
- Fewer colors, style choices, system only availability, more PET
- Follow cars for upscale SUVs
- Increased personalization (6 comments)
- Interior designed/styled to integrate more features, e.g., navigation, entertainment electronics and displays; a return to matching interior colors throughout as opposed to standard colors (e.g., gray IP)
- Larger, easier to use gauges, buttons, controls, etc.; increased trend toward luxury (comfort and convenience) features

- Lightweight seat construction in aluminum or magnesium
- More provisions for storage and placement of carry-on items such as purses, cell phones, PCs, brief cases, beverage containers, etc.
- Movement away from leather, a reduction in seat volume, "home away from home" theme, more ergonomic seating throughout, environmentally friendly materials, more interior space
- Office-in-car theme, more material change
- Owner "personalization" packages - allow owners to individualize their vehicles; changeable seat covers
- Personalized and replaceable trim.
- Reposition or elimination of traditional controls due to incorporation of safety. Devices like side airbags.

Light Trucks

2000:

- Additional "accessory" features such as CD storage module, kleenex dispenser, garbage box, cup holder, change storage, etc.
- Functional improvement
- Further moves toward passenger car styling
- Greater use of integrated seat belts.
- Harmonization
- Improved technology in noise suppression.
- Integration of (personal) computing capability.
- Lighter-colored interior surfaces, e.g., IP and other interior trim; 2-tone IP upper/lower, "softer" touch/feel surface materials
- More "car-like" interiors. Expanded optional "luxury" items.
- More modularization of controls, i.e., audio and climate control pod, continue earth tone colors
- Move to leather, more contour seats - body forming, more car-like interiors
- No appreciable change.
- Passenger car-like interiors
- Seamless PSIR systems
- Simpler and commonized door trim, total harmony of color and materials
- Simplified interior instrumentation layout
- Some materials, some harmonization but the theme will be "flexibility."

2005:

- Colors become brighter, more radical ultra fighter type cockpit designs, fighter grip steering
- Continue trend toward car-like features stressing comfort and convenience
- Fashionable
- Further moves toward passenger car styling, same types of styling as above
- Increased personalization
- Increased personalization, voice activation, modularization
- Interior designed/styled to integrate more features, e.g., navigation, entertainment electronics and displays; a return to matching interior colors throughout as opposed to standard colors (e.g., gray IP)

- Lightweight seat construction in aluminum or magnesium
- Material changes and personalization changes as the various needs of the truck consumer change
- More personalized, trending to cockpit; design with renewed emphasis on safety
- More provisions for storage and placement of carry-on items such as purses, cell phones, PCs, brief cases, beverage containers, etc.
- Movement back to rugged fabrics
- No appreciable change.
- One size fits all system, incorporation of more safety features, movement toward multicolored styling/design.
- Personalization theme
- Side airbags

Discussion

The panelists list a wide variety of styling changes and themes for the coming decade. While styling cues for 2000 are already set, themes for beyond are still very much in development.

Strategic considerations

Interior styling presents one of the truly great avenues for product differentiation. The continued implementation of brand management may present an even greater impetus for styling differentiation. As vehicles become increasingly marketed to and designed for specific lifestyle segments, the constraints for the functionality of interiors will vary depending on customer needs. In past years, there have often been modest differences between the interiors of compact cars and midsize cars, or even between midsize cars and luxury cars. Light truck interiors were often even more similar. As suppliers and assemblers become more adept at agile manufacturing, interiors will certainly be tailored to meet the specific needs of targeted customers. The next decade may present stylists, designers, and engineers with the opportunity to go beyond the traditionally accepted design envelope and create driver-vehicle interfaces that markedly change the way customers use their vehicles.

INT-5. What changes in *interior* durability standards do you anticipate and what methods, design, material, or manufacturing changes will allow the industry to meet those changes by 2005 (i.e., color fade, squeaks and rattles, etc.)? [Underlined headings represent OSAT groupings of common ideas.]

2005:

Buzz/squeaks/rattles(BSR)

- Continuously increasing durability standards - changes that will allow/facilitate no buzzes/squeaks and rattles mainly involve designing whole systems together at same source, whether it be OEM or supplier
- Material developments and modularization will be necessary to reduce BSR.
- Most changes will be in design and material with a smaller amount of effort in manufacturing.
- Only predictable and presentable squeaks and rattles will be acceptable.
- Squeaks and rattles must be eliminated.
- Squeaks and rattles will be unacceptable.
- Tougher squeak/rattle resistance

Material standards

- 10 year/200,000 mile durability - TPU or TOP/TPE chemistry; simplified construction from skin/foam/insert to simple polymer 2-layer construction
- Continued development of longer lasting, more durable materials, more "worldwide" standards applications (i.e., GCC air conditioning standards).
- Expect increased standards for sound deadening.
- Expect reduced use of vinyls - change to TPO/TPE. TPUs will remain too costly. Change to TPO skins will drive development of olefinic foams. An alternative is the development of environmental screening glass.
- Longer time and higher temperature testing of instrument panels are anticipated. More reflective windshields, polyurethane skins and semirigid polyurethane foam systems that do not cause vinyl staining are also anticipated.
- Specifications for fire and heat cycling endurance will be increased, as will specifications for, color fastness in strong sunlight, and standards for IPs (non-cracking 10 year durability).
- Tougher specs on materials - less warpage/expansion/contraction for fit and finish - with movement away from plastics like ABS

General changes to current standards

- 10 year durability standard on minivans anticipated. Expect the elimination of the instrument panel as we know it. Modularization and single process manufacturing are anticipated to eliminate squeak and rattle issues.
- Expect verification of capability of component to meet durability specs, and standards for actual 10 year/150,000 mile durability - data certifications and methods of test, and computer model methods will be used.
- I don't think interior durability standards will change significantly beyond the "general trend" of all vehicle components being designed for slightly longer life.
- Major changes in Europe are driven by recycling and durability. Durability standards are driven by GM and Europe - expect 10 year/200,000 durability by 2005.

- There has been a decline in requirements. This will change after customer feedback. New yarns and seatings will raise standard on abrasion requirements as well as fade.

Other

- Changes are expected to impact energy management, and lead to more recyclable and lower cost interiors.
- Expect larger modules/systems, and low UV glass to become more prevalent.
- I expect the ability to update interiors - adding new technology features, etc.

Discussion

The panelists comments on future durability standards focus on buzzes/squeaks/rattle (BSR) and more stringent material requirements. Standards for these two areas, along with the others mentioned are forecast to get increasingly severe.

Strategic considerations

The effort to reduce buzzes/squeaks/rattles (BSR) is an excellent example of the potential gains to be made by well-executed systems engineering. The trend to increased structural stiffness of the body will help reduce BSR as well. Furthermore this added stiffness will help vehicles "age" well; i.e., maintaining almost new car "solidness" for a number of years. The ability of a skilled systems integrator to design, engineer, and manage a program that results in a quiet, well-fitting interior system can become a competitive advantage for the assembler. It is important to note that not all system integrators will excel at systems engineering. Discipline, communication, project management and trust will be key elements in the successful application of a systems integration strategy.

Cost concerns have led some assemblers to assess the potential for relaxing some material standards. This, however, is not expected to be a continuing trend. Most panelists expect material standards to increase in the coming decade. Durability, fade resistance, and another similar measures are expected to become increasingly more severe. An added challenge for materials engineers will be to find more environmentally friendly materials, both in terms of manufacturability and recyclability. Green manufacturing systems and products will become increasingly important in the coming decade.

INT-6. "Partnering" is a popular term used to describe future manufacturer/supplier relationships. However, there is no common definition of "partnering." From your viewpoint, what are the five most critical concepts, characteristics, or features of "partnering"? [Underlined headings represent OSAT groupings of common ideas.]

Capabilities/synergy

- Capabilities (technical and business)
- Each partner has a core competency, and strengths that the other partner does not
- Filling voids when you can't do everything
- Increase systems engineering via closer working relationships between OEM and supplier
- Leveraging existing capacities/resources
- Melding of corporate cultures
- Recognition of unique manufacturing specialties
- Shared development and validation capabilities
- Shared program management
- Synergy (sum greater than individual parts alone)
- The ability to go after applications individual firms could not
- Use of both companies' expertise to reach end goal
- Utilizing research/development together for new products
- Working as a team to attain target
- Working together to bring product to market

Problem resolution

- Abandon punishment approach to dealing with supplier mistakes
- All differences should be resolved through negotiations.
- Corrective action should be focused on the product to ensure targets are met.

Long term commitments/planning

- Commitment to the long term
- Improved long range planning
- Long term agreements/contracts
- Long term stability for supplier
- Long term supplier understanding of OEM needs and design intentions
- Long-term commitments
- Mutually agreed pricing and future objectives
- Predictability of length of supply contract
- Sharing of long term profitable growth strategy
- Up front agreement that two (or more) companies will do business together
- Up front design in total relationship
- Well defined responsibilities, boundaries

Open communication

- Each party understanding the business of the other
- Effective personal relationships
- OEM sharing of system/subsystem cost targets
- Open communication between partners
- Open communication of information/ideas
- Open communication of needs
- Openness regarding future product programs
- Openness of discussion/frankness in assessment
- Understanding what the customer wants

Proprietary concerns

- Commercial agreements
- Confidentiality of new ideas
- End auction-type sourcing
- No re-sourcing
- Proprietary processes
- Recognition and confidentiality of supplier patents/innovations

Cost considerations

- Cost reduction proposal
- Cost reductions
- Cost sharing strategy
- Profit
- Profit sharing strategy
- Reducing cost and improving quality by working together
- Shared cost reduction
- Sharing of costs
- Target pricing (2 comments)

Equal Benefits

- Appropriate OEM/supplier rewards
- Collaboration with mutual benefit in outcome for both/all parties
- Each party must clearly benefit on its own terms.
- Explicit recognition of mutual benefits
- Win/win (3 comments)

Common Vision/Shared Goals

- Capability of one partner to have different financial goals than the other.
- Commitment to cost, quality target from early stage
- Common goals (6 comments)

Equal Distribution of Risk

- Shared risk (3 comments)
- Supplier acceptance of risk (i.e., warranty, recalls, etc.)

Trust/Credibility (19 comments)

Other

- Common view of "value chain"
- Consistent order - consistent work force - less turn over
- Corporate management champion exists at each firm
- Dependable utilization of supplier skills
- Early involvement of supplier in design and application
- Finite life
- Increased dependence on supplier (i.e., OEMs give suppliers complete system responsibility)
- Joint marketing
- Rapid prototypes to test what has been done on paper
- Resource focus on design, development, manufacturing
- Shift of advanced development down the supply chain
- Supplier must be thought of as an equal partner
- Very early involvement in design, styling for suppliers

Discussion

The panel most frequently responded with trust and credibility, win/win outcomes, capabilities/synergies, long-term commitment/planning, and cost considerations as critical characteristics or factors for partnering.

Strategic considerations

Over the last decade, the North American automotive industry has undergone a re-engineering of many processes. Practices that traditionally governed the industry no longer apply. As companies struggle to define the future, no element of change has been more challenging and controversial than the supplier-assembler relationship. The design, manufacture, and management of interior parts and components, once the domain of the assembler, is now handed off to systems integrators. As traditional boundaries vanish, friction often develops over roles and responsibilities.

Critical to the fair and successful resolution of these conflicts is the development and acceptance of an agreed upon ethical code, and an earned trust between all partners.

In an industry that has often had difficult supplier-assembler relationships, the development of trust is both of the utmost importance and the most difficult challenge. System integrators are being brought into programs earlier than ever, and are given complete system responsibility from the initiation of the project. Assemblers are required to trust the supplier with the most sensitive of program information and the responsibility for safety and quality standards. The willingness of assemblers to end so-called shadow engineering will mark a major step forward, not only in cost reduction, but also in terms of trust.

Conversely, suppliers must take a leap of faith and accept that the assemblers will adequately reimburse them for engineering and program management costs. The decision to become partners is only the first step of a long and evolving shift toward a trust-based system.

Another issue in OEM-supplier relations is the ability to effectively manage the entire supply chain where trust is highly desirable at every interface in the chain.

INT-7. What do you believe are the five major issues and long-term strategic considerations underlying the current trend by U.S. vehicle manufacturers toward reliance on interior systems suppliers? Please consider all aspects including, management, manufacturing, and design/engineering. [*Underlined headings represent OSAT groupings of common ideas.*]

1 - Cost reduction

- Ability to provide systems at low cost
- Cost sharing from OEM as well as supplier
- Huge increase in hierarchy and cost by tier-1 suppliers
- Improved cost to OEMs through modularization (less assembly at OEMs)
- Major suppliers and pressure to reduce cost are drivers
- OEM belief that it is a lower cost alternative
- OEM realization that cost reduction is a two-edged sword—both OEM and supplier must corporately reduce cost
- OEMs transfer of as much cost and responsibility to suppliers as possible
- Reduction in the size of the economic vehicle production module
- Relative costs - vehicle manufacturers comparing their high cost against lower costs of suppliers
- Transfer of cost away from OEM

2 - Globalization/sourcing

- Increased worldwide manufacturing in lower wage regions
- OEM and supplier development of joint strategies for globalization of platforms
- Regional manufacturing technologies (Europe vs. United States) making single product designs difficult to achieve for global vehicles

3 - Modularization/systems integration

- Component compatibility
- Design harmonization
- Ease of assembly
- Improved cost to OEMs through modularization (less assembly at OEMs)
- More systems integration by suppliers
- Simplified OEM systems integration
- Styling compatibility
- Uniform interior appearance

4 - Supplier capabilities

- Ability to organize/manage a system small enough to get your hands around
- Adequate staff to handle design and development
- Development of a true partnership that will allow the OEM to incorporate the use of supplier technology into the design
- Engineering competence
- Engineering resources (resolve the lack of resources at the OEMs)
- Expertise in a specific area
- Financial capability of system supplier
- Less capable suppliers in the areas of engineering/technology
- Less styling and material/components innovation from system suppliers
- Real capability of supplier
- Reliance on expertise of the supplier
- Shifting of the focus on quality to suppliers
- Suppliers must develop OEM equivalent engineering development, and test capability
- Systems suppliers ability to recover engineering and project management costs
- System suppliers are weak in tier-2 management
- System suppliers' effective utilization of tier-2
- Systems suppliers increasing their total capabilities
- The realization that the best technologies do not always reside with systems supplier
- Tier 1/Tier 2 relationships resembling past OEM/Tier 1 relationships
- Too few companies capable of doing job

5 - OEM considerations

- Ability to achieve shorter lead times
- Issue: "letting go" by U.S. vehicle manufacturers
- Less investment by OEMs
- OEMs "shadow" of supplier engineering
- OEMs focusing only on what they feel they can do fast
- Payment for a service formerly provided by a vehicle manufacturer
- Programs change direction before suppliers are "fully-on-board" (supplier is more remote than even OEM, making program direction changes harder to assess and implement)
- Quick response - reduced cycle time
- Reduced lead times
- Suppliers and OEMs failure to share common financial and customer satisfaction goals
- Suppliers and OEMs failure to share harmonized manufacturing standards
- The ability for OEMs to outsource/off load design and purchasing
- Trust/creation of a true extended enterprise

6 - Union commitments/concerns

- High cost and labor productivity of unions
- Inability of OEMs to manage in-house component and system operations
- Labor contract restrictions (in-house vs. out-source)
- Reduction of OEM labor content
- Replacement of union workers with non-union workers

7 - Shift of warranty

- Management of warranty responsibility
- System suppliers ability to protect themselves from recall expenses
- Warranty and product liability responsibility

8 - Mega supplier concerns

- Long term competitiveness may suffer, given too few suppliers.
- Market implications of too few, very large suppliers
- Size of systems suppliers could make them difficult to deal with and actually increase cost.

9 - Quality (3)

All Other selected edited comments

- Ability to locate system facility at optimal place
- Decree that an approach or process can be used for competing customers
- The greater industry commonization resulting from fewer suppliers
- Higher quality resulting from a single source for entire systems
- Recyclability

Discussion

Panelists list the ability to leverage suppliers' capabilities as the most common strategic consideration by vehicle manufacturers in their desire to increase system sourcing. Other issues of strategic importance mentioned by the panelists include cost reduction and modularization.

Strategic considerations

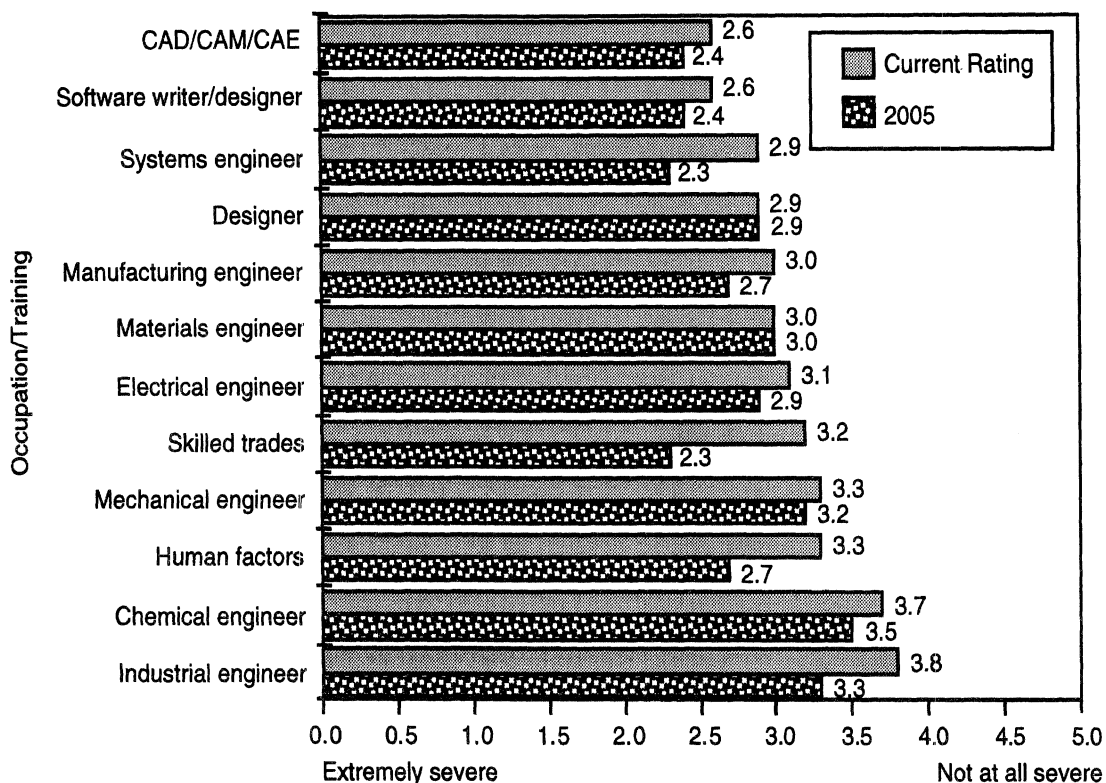
The automotive interiors sector has experienced a significant shift to a systems integration strategy. The panelists list several considerations that have accelerated that trend.

From the assemblers point of view, the enticement of leveraging their suppliers' skills and capabilities to reduce costs is the driving force behind the shift toward a system supplier strategy. However, merely shifting responsibilities from assembler to supplier may not necessarily mean reducing costs. Vital to the success of such a strategy is the capability of the supplier to be an effective systems integrator. As suppliers are asked to assume increased responsibility for design, engineering and management of complex systems, some will excel while others will have difficulty. Those that become skilled managers of complex systems will likely offer their customers lower costs, higher quality, increased flexibility, and other important attributes.

INT-8. Please indicate your estimate of supply deficiencies for the following skill areas and job functions currently and in 2005. Please consider all aspects of the automotive interiors sector.

Where 1 = extremely severe, 3 = somewhat severe, and 5 = not at all severe.

**Estimate of Supply Deficiencies for Selected Skilled Areas and Job Functions:
Current and 2005 (Forecast)**



Selected edited comments:

- General technical shortage in classic heavy industry, due to attractiveness of high-tech firms and industries providing higher compensation. Auto industry does not attract the best, as computer skills are generally poor.
- Non degreed skill trades will decrease unless apprenticeship programs are installed.

Discussion

The panelists rate all listed job functions and/or skill areas as somewhat severely deficient currently. They also expect the supply of each of the listed skills to become increasingly deficient in the coming decade.

Strategic considerations

The human resources issue is of growing importance in the automotive industry. Limited availability of skilled people at all levels could sharply impede the industry's move to reinvent itself around a leading-edge workforce. Our research continues to show that this is a growing problem and is exacerbated by the current high rates of retirement and rapid changes in technology.

The points raised in the comments regarding the attractiveness of the industry to leading edge knowledge workers and the lack of apprentice programs are of major significance.

INT-9. Purchasing criteria priorities change over time. Given the following supplier attributes, please indicate the importance of each to North American vehicle manufacturers currently, and in 2000 and 2005.

Where 1 = very important, 3 = somewhat important, and 5 = not important.

Supplier Attributes	Mean Rating		
	1996	2000	2005
Price	1.2	1.3	1.5
Delivery performance	1.6	1.5	1.4
Quality performance/rating	1.7	1.4	1.3
Manufacturing competence	2.0	1.7	1.5
Engineering competence	2.2	1.8	1.5
Effective management of supplier's supply base	2.9	2.4	2.0
Supplier's long-term relationship with customer	2.9	2.5	2.1
Design and styling capability	3.1	2.3	1.8
Ability to operate as a system supplier	3.2	2.1	1.4
Effective management of supplier human resources	3.2	2.8	2.6
Availability of modular assemblies	3.3	2.2	1.5

Other Single Responses:

By 2005 OEMs will be wary of the big all purpose supplier because of the power they have. Too much like Fisher Body of the '60s and '70s

Human factors capability: 1996 - 3; 2000 - 2; 2005 - 1

Payment schedule: 1996 - 1; 2000 - 1; 2005 - 1

Responsiveness: 1996 - 3; 2000 - 2; 2005 - 2

Which other vehicle manufacturers sell to: 1996 - 4; 2000 - 3; 2005 - 2

Selected edited comments

- Perception is that vehicle manufacturers do not know their own internal costs when comparing to outside suppliers.
- Price is currently "king." Decreasing the number of suppliers may shift emphases more towards service and quality issues.

Discussion

Panelists rate price (1.2) as currently the most important purchasing criteria. The forecast for 2005 rates quality performance/rating (1.3) as the most important criteria. However, it is important to note that the forecast for 2005 includes seven criteria between 1.3 and 2.0.

Strategic considerations

The panel leaves little doubt that price is currently the most important decision factor for assemblers. They also rank delivery and quality as factors that are currently critical. Industry observers suggest that these three attributes may merely represent a ticket for entrance to the

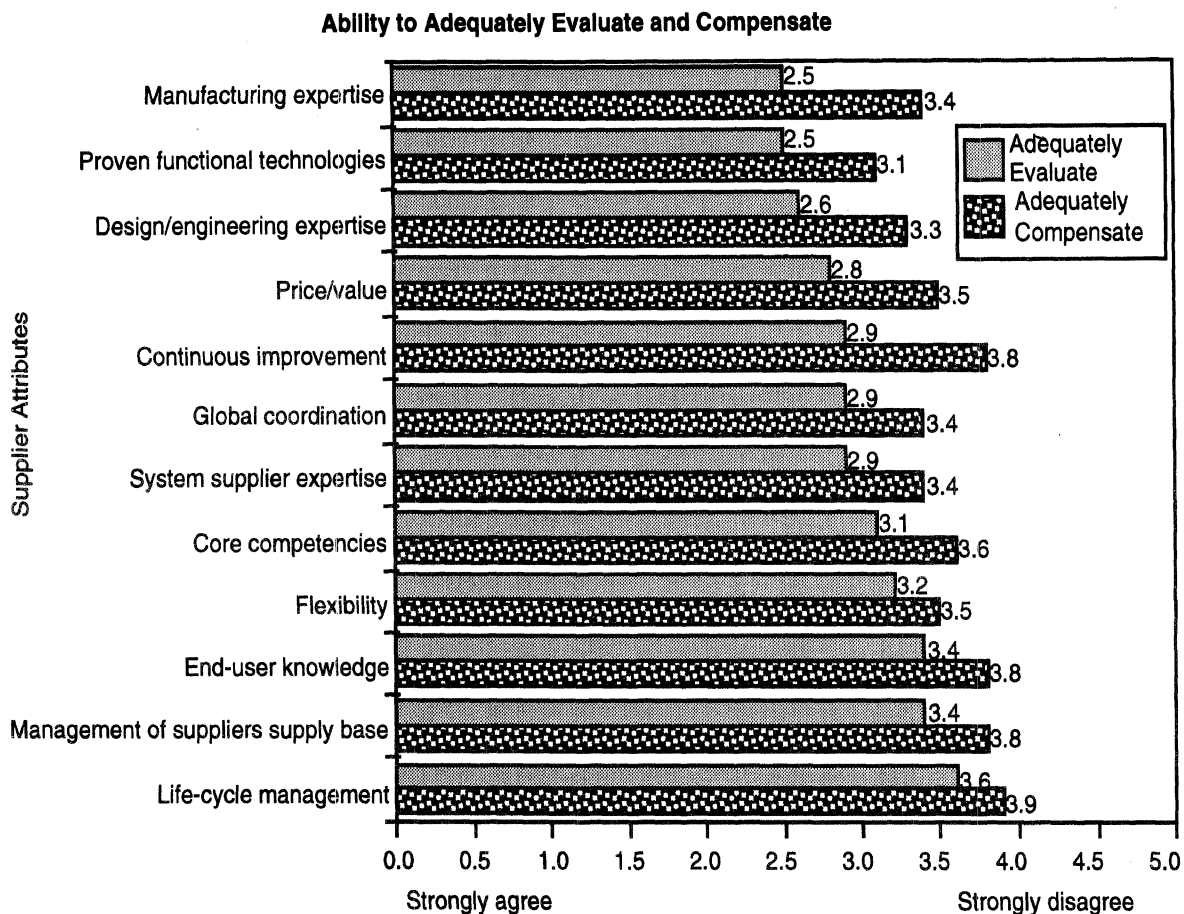
automotive industry. Companies that wish to be competitive must be capable of meeting strict price, quality, and delivery targets.

The fact that price, followed by quality and delivery, are currently the most critical attributes is not surprising; neither is the fact that those three attributes are forecast to be of similar importance in the coming decade. What is, however, especially noteworthy is the number of other attributes that are forecast to be as critical as the top three by 2005. The 2005 forecast includes eight attributes with ratings of less than 2.0. No longer will companies be able to survive on their strength in a few operational skills. Instead, they will be required to excel in all aspects. This pressure to excel will be further challenged by the pressure to reduce lead times and by an era of ever decreasing resources.

Finally, the traditional North American automotive industry is facing a human resource crisis. As the workforce population ages, attrition due to retirement will affect the "Big Three" and many of their traditional suppliers. This attrition may represent an opportunity for the industry to redefine the workforce, yet it will also be challenged to replace the knowledge and unique skills that are represented in the many years of experience. Of course, old and obsolete knowledge is lost as well, which is the positive side of worker turnover.

INT-10. There is debate regarding increased requirements for suppliers without direct vehicle manufacturer compensation. Please indicate your belief that the vehicle manufacturers adequately evaluate and compensate suppliers for these activities.

Where 1 = strongly agree, 3 = neither agree nor disagree, and 5 = strongly disagree.



Other Single Responses:

In house supplier: Evaluate - 1; Compensate - 1

Size: Evaluate - 3; Compensate - 3

Selected edited comments

- Big disconnect between OEMs and suppliers on this!
- Have found that there is a lot of movement of personnel between companies resulting in an ongoing re-informing of personnel. This also applies to many new engineers/technicians entering the industry.
- The issue obviously is that some OEMs embody partnering while others seem never to be wrong nor recognize accomplishment. Another OEM evaluates surplus using price as the only driver. It's difficult to thus provide an "averaged" response.

Discussion

Panelists rate manufacturers' ability to evaluate programs as more adequate than their ability to adequately compensate the programs. Continuous improvement, manufacturing expertise, price-value determination, and design engineering expertise are the activities that panelists rate as exhibiting the greatest disparity between adequate evaluation and compensation.

Strategic considerations

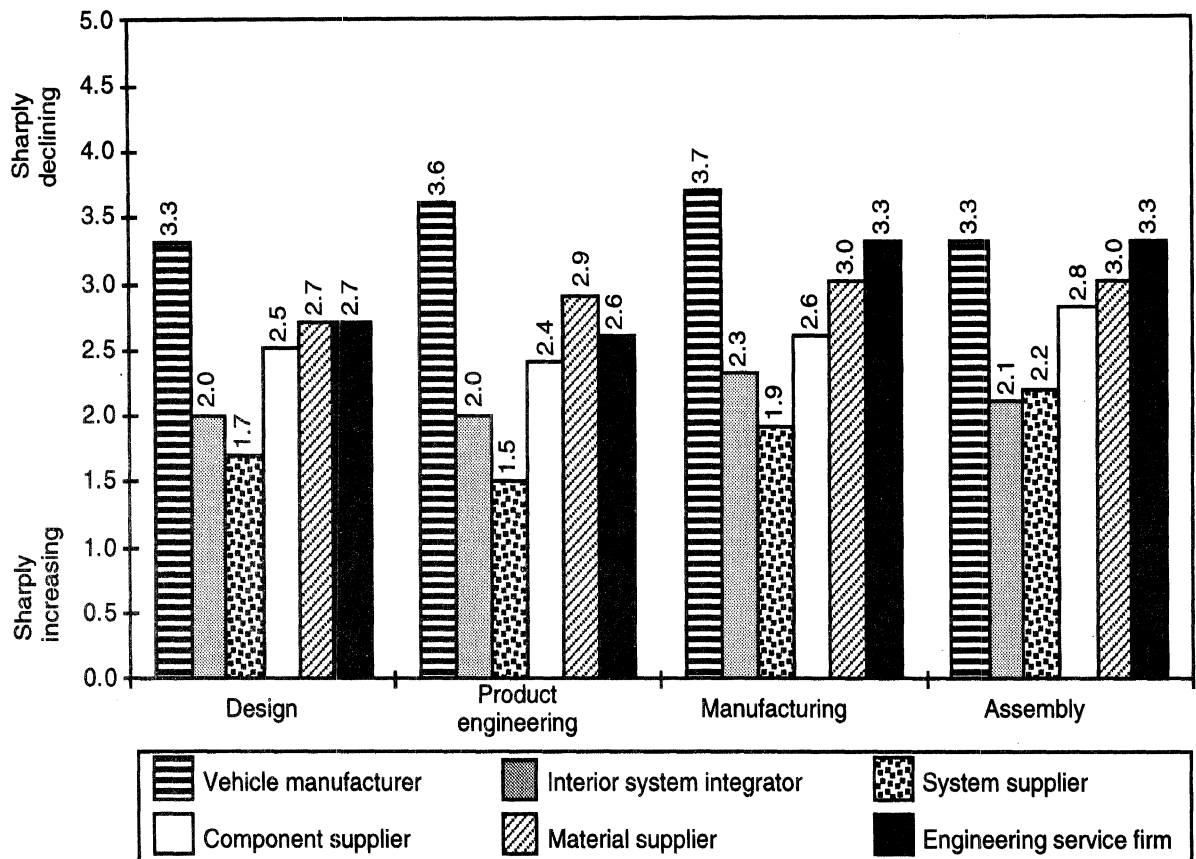
There is probably no more divisive element of the assembler-supplier relationship than the issue of adequate evaluation/compensation. The perception of what is adequate compensation is often markedly different for the two parties. As the industry focuses increasingly on cost reduction, assemblers must carefully determine what activities add value to their products, and eliminate those that do not. Merely shifting costs to suppliers will not strengthen the system, nor reduce costs. However, the ability of a supplier to add value must not be overlooked, and must be properly compensated if the entire value chain is to function at a world class level.

As design, engineering, and project management activities are increasingly outsourced to suppliers, the willingness of an assembler to adequately compensate suppliers for their increased responsibility becomes even more critical. It is interesting to note that various assemblers are following markedly different supplier relationship strategies. Some are pursuing a relationship-based strategy, while others have chosen to base supplier selection on transaction-based contracts. It is highly likely that companies that supply assemblers pursuing a relationship strategy may be more likely to agree that their customer adequately evaluates and compensates them. Suppliers that are faced with an assembler that does not adequately compensate may choose to reduce the amount of business with that customer.

INT-11. Considering the next 10 years, please identify the changes in value-added by each interiors industry participant you expect at each functional stage.

Where 1 = value-added sharply increasing, 3 = remains the same, and 5 = value-added sharply declining.

Changes in Value-Added for 2005: Interior System Integration

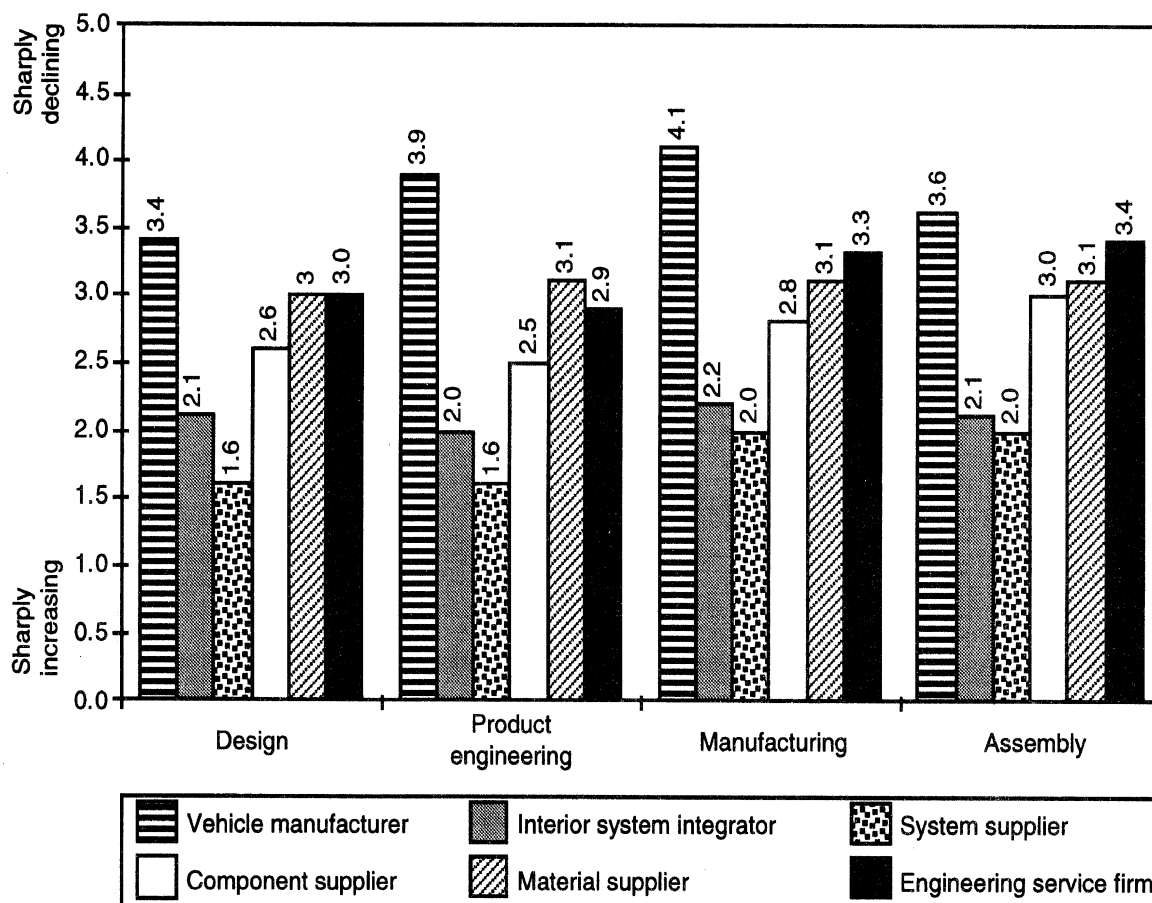


Selected edited comments

- A future “trainwreck” may result from “too many cooks spoiling this broth.” OEM input will still exist and not subside. Suppliers will be asked to do more, too, leading often to gridlock.
- Added value also comes from up-front requirements derived and translated from the voice of the customer and other customer-based methodologies. Effective integration starts with balanced requirements. This is still the responsibility of the vehicle manufacturer and something the manufacturers are getting better at doing.
- Anticipate GM/Delphi unit to be broken up and sold within 5 years - huge cost, relocations - restructuring will likely result. Anticipate Ford ACD to be sold in 5-7 years.
- GM Delphi and Ford ACD are considered to be suppliers, not OEMs.
- Systems integration will only succeed if OEMs are willing to macro manage and not micro manage the systems.
- The systems suppliers are learning to be systems integrators. Many OEMs are intrigued and entertaining proposals.

Where 1 = value-added sharply increasing, 3 = remains the same, and 5 = value-added sharply declining.

Changes in Value-Added for 2005: Cockpit Module

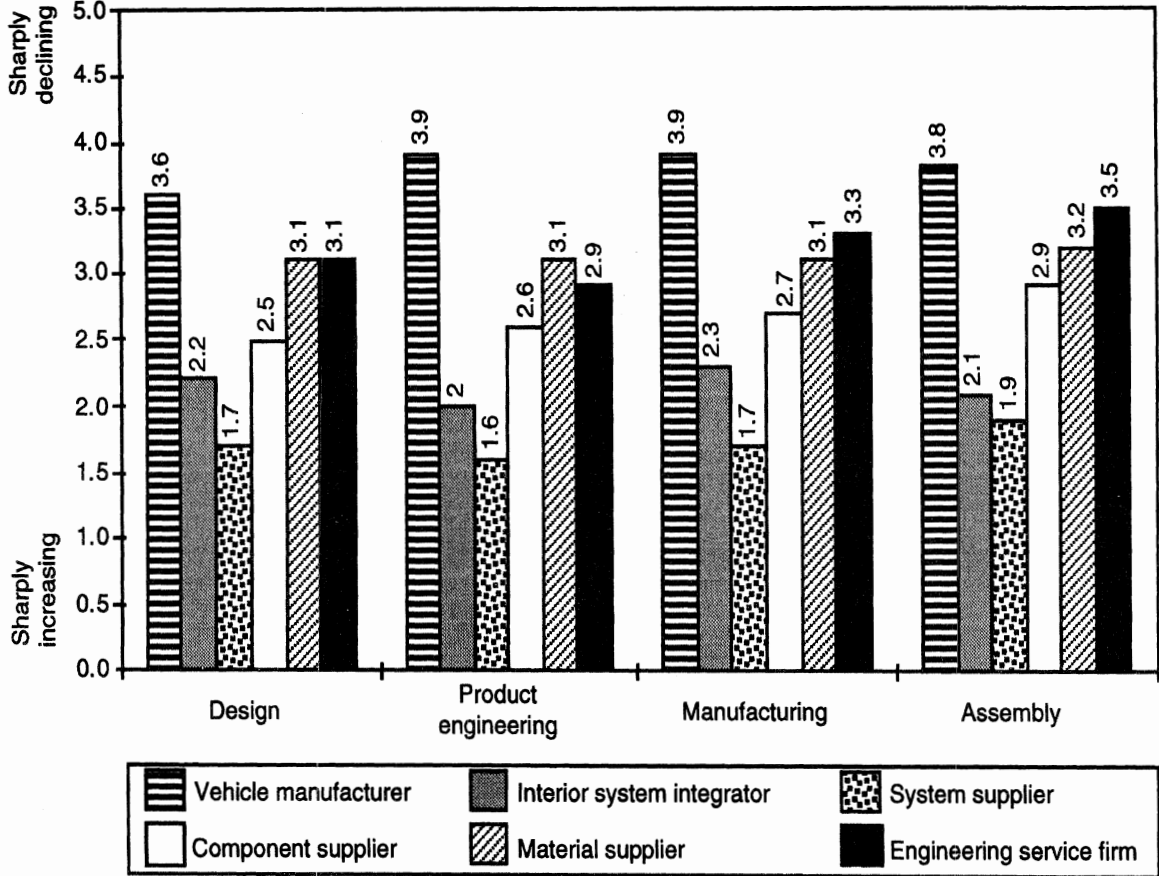


Selected edited comments

- There is hard evidence of this trend emerging in North America and Europe as OEMs test the concept in current and new programs.
- Value-added comes in the form of information--i.e., requirements and specifications, just as much as it does from detailed design and production.
- Vehicle manufacturer's styling and system integrator/system supplier teams are pushing the limits of co-location proprietary issues; timing is becoming a huge issue.

Where 1 = value-added sharply increasing, 3 = remains the same, and 5 = value-added sharply declining.

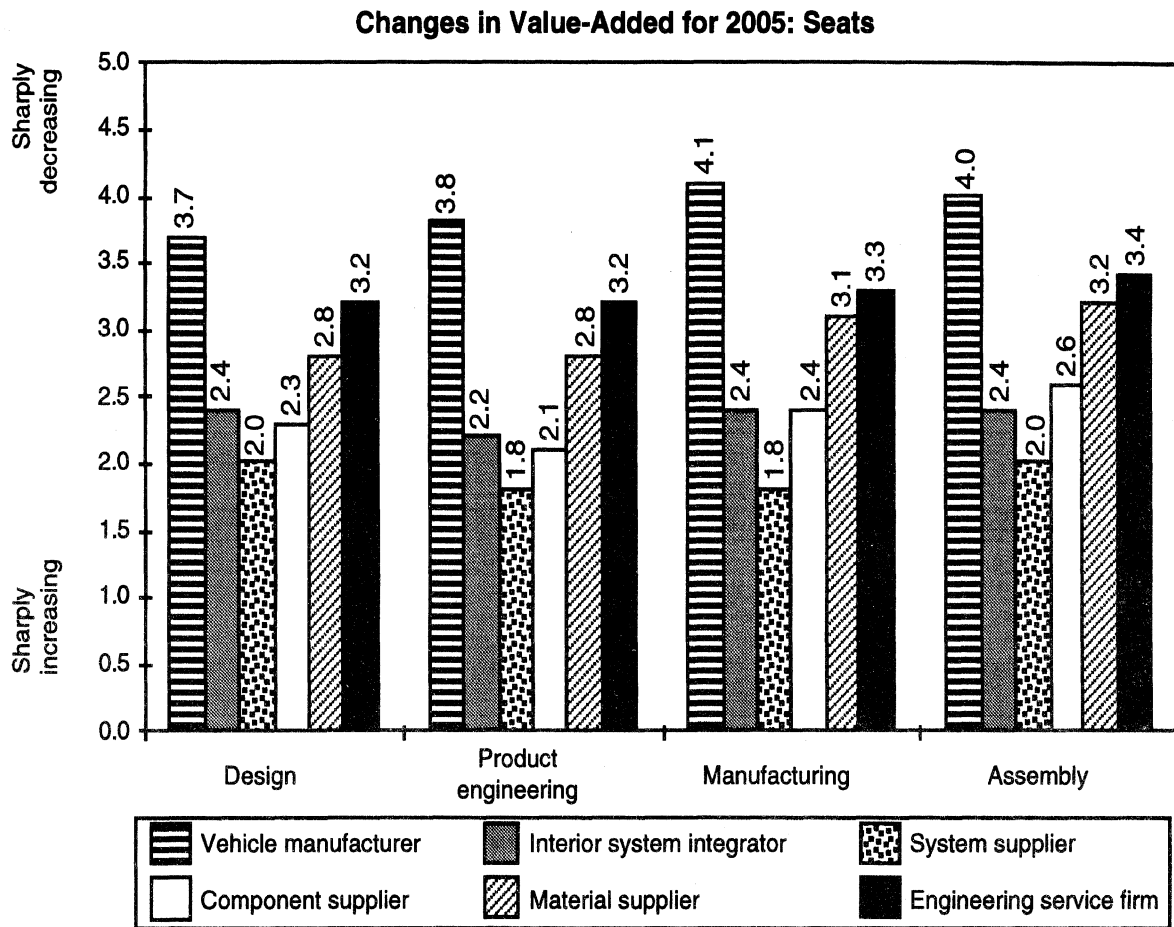
Changes in Value-Added for 2005: Door (inner)



Selected edited comments

- Door inners are expected to become more complex - including safety, structure, electronics, NVH - requiring a system supplier capability upgrade.

Where 1 = value-added sharply increasing, 3 = remains the same, and 5 = value-added sharply declining.

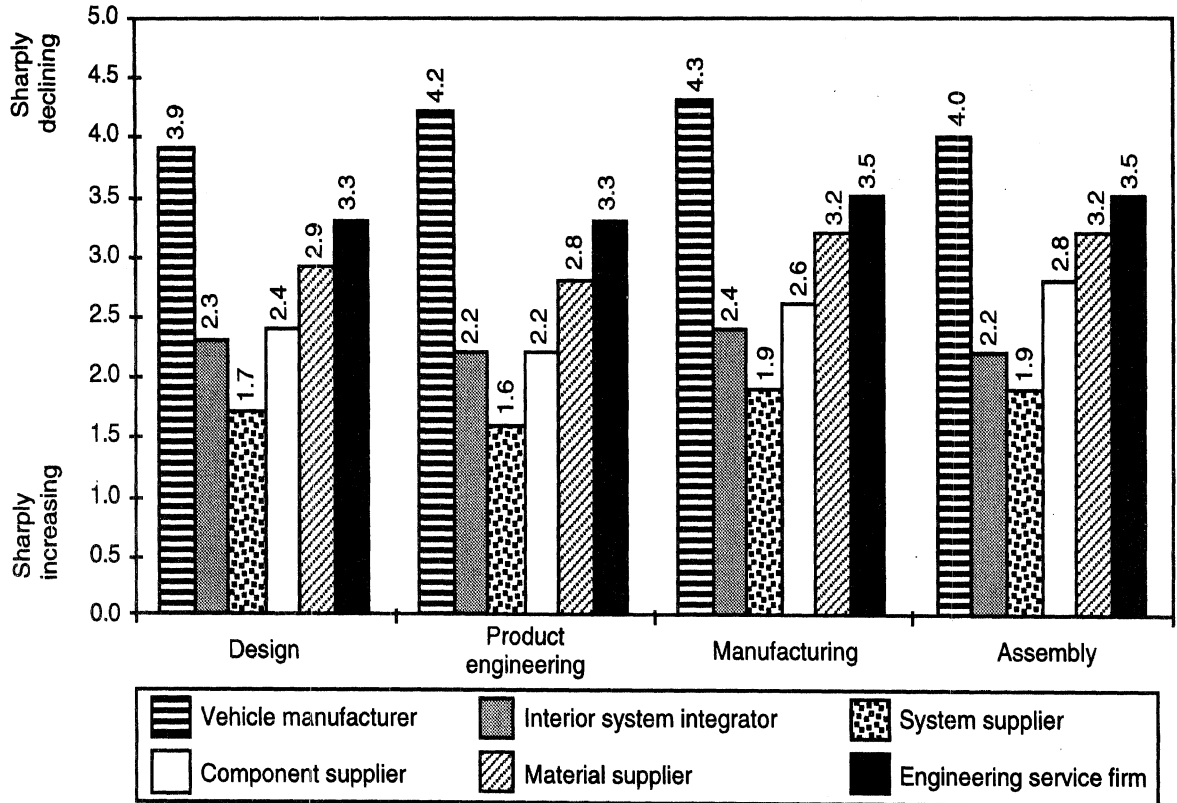


Selected edited comments

- In many cases the system integrator, system supplier and component supplier may be the same company, e.g., Lear, JCI or Magna.
- Its hard to imagine any plant building up their own seats within 10 years.
- Seating becomes more safety critical - vehicle manufacturers will take back more responsibility.

Where 1 = value-added sharply increasing, 3 = remains the same, and 5 = value-added sharply declining.

Changes in Value-Added for 2005: Headliner

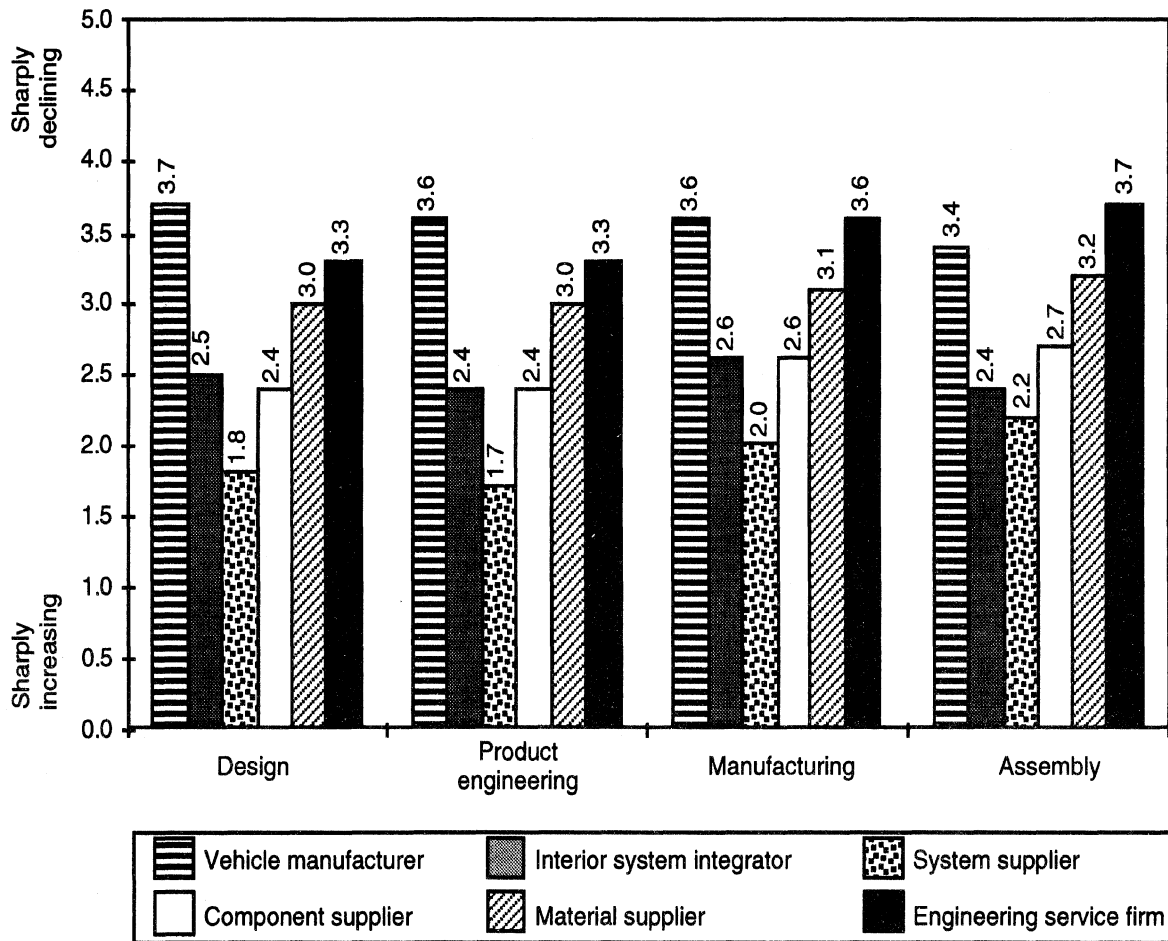


Selected edited comments

- Headliners are expected to become more impact and acoustics critical, adding more engineering content.
- Headliners are increasingly being sourced as part of an overhead system.
- The move away from fiberglass will require somewhat more value-added in the product engineering area by the material supplier.

Where 1 = value-added sharply increasing, 3 = remains the same, and 5 = value-added sharply declining.

Changes in Value-Added for 2005: Electrical/Electronics



Selected edited comments

- Electronic content will increase again, and suppliers will contribute heavily to systems and components designs.
- Electronics is a sector where OEM engineers are usually far behind the times. The expertise truly lies in the hands of the supplier community.
- The need to drive down costs in electronics/electrical systems will drive standardization and multiplexing. Advances in software and hardware (HP - Microsoft), will allow OEMs to catch up.

Discussion

Panelists forecast value-added by vehicle manufacturers to decrease for all listed components/systems. Conversely they forecast increased value-added by interior system integrators, system suppliers, and component suppliers.

Strategic considerations

The interiors industry has undergone a major transformation over the past decade. A select number of component suppliers have become system suppliers, and an even more select group of them are moving to become system integrators. The shift to a system supplier strategy has been dynamic, and at times difficult. The mergers and acquisitions of recent years have quickly

reshaped the automotive interiors sector. The changes will likely continue for the foreseeable future.

Panelists forecast increased valued-added for systems suppliers and system integrators in all listed systems and functional stages. As manufacturers increasingly rely on suppliers for design and engineering, it will become more important to select capable partners. Some estimate that the first 5 percent of parts design controls over 80 percent of the overall cost of the project. Reliance on a skilled system integrator will likely lead to significant advantages; however, the selection of a less than adequate integrator may lead to high-cost, low-quality solutions.

Material suppliers include a wide range of companies with skill levels that are as different as the materials they represent, and therefore warrant special note. Many of the larger material suppliers are actively involved in product design, working closely with higher-tier suppliers and manufacturers to incorporate their materials into future products. We expect these relationship to continue, and to even possibly increase in frequency and depth. Examples such as ALCOA's cooperative work with Audi to develop the aluminum intensive A8, and their partnership with Chrysler on the Plymouth Prowler represent highly visible instances of a material supplier moving up the value-added chain to support the role of the system integrator.

In general, panelists forecast the level of value-added by engineering service firms to remain relatively stable. We find this to be somewhat puzzling. As second- and third-tier suppliers are asked to do increased amounts of design and engineering, industry observers have suggested that a cost-effective way for these companies to respond to the increased work is through the use of engineering service firms. The panel does not appear to reflect that idea. Engineering service firms represent a highly dynamic segment of the value-added chain, and therefore should be closely watched in the coming decade.

INT-12. What assembly plant installation challenges do each of the following interior systems/components present? *[Response categories provided shown in bold below; underlined headings represent authors groupings of common ideas].*

Instrument panel:

- Handling of new designs.

Concerns regarding alignment with body in white (BIW):

- Body in white alignment (6 comments)
- Combining cross-car beam with instrument panel support structure
- Control of sheet metal dimensional stability
- Cross car alignment/fit to body in white (BIW)
- Cross car tolerance compatibility
- Reducing complexity for assembly with cost efficient modules
- Simplifying future assembly plant problems through design
- Varying sheet metal tolerances in multiple interfaces

Testing and verification of electrical/electronic systems:

- Building the instrument panel with foolproof electrical connectors with 100% electrical checking; installation of preloaded airbag systems with 100% inspected sensors and electrical components
- Final testing of wiring and electronics together
- Testing of electronics (3 comments)

Other:

- Ability to deliver systems; SPD limiting modularity
- Handling size
- No different from current
- Safety concerns with pre-assembled airbags, damage due to additional handling; ownership of parts which are damaged
- Structural integration and implications of shape changes (e.g., round vs. square)

Cockpit module:

- Ability to deliver systems; SPD limiting modularity
- Build and weight of module requiring more manpower or different machinery to install
- Complexity and handling
- Control of sheet metal dimensional stability and weight reduction
- Electrical/electronic attachments and impact zone airbags
- Implications of OEM labor content/union promises on ability of supplier to provide complete system
- Installation, alignment, fit
- Module alignment to X, Y, Z coordinates and dimensional control of the BIW to assure proper tolerance of all mating coordinates and matching surfaces
- Number of components
- OEM focus on processing of complete module
- Problem resolution in which vehicle function is affected - ease of assembly due to size and complexity
- Size/mass; cost

Door assembly (inner):

- Ability to deliver systems; SPD limiting modularity
- BIW dimensional control of X, Y, Z coordinates for door aperture body sides, door opening and door surface to insure trim match and mating
- Challenges related to greater electrical density—greater number of connections, greater weight
- Installation, harness connections
- Labor issues
- No more than today

Matching interior/exterior:

- Off-line assembly to accommodate complete door systems while matching color
- The complexity of matching exterior and interior components makes quality assurance more difficult - if internal components fail, need to replace entire door - JIT delivery may make this difficult.

Electric/electronic:

- 100% electrical system continuity and connector inspection; assurances of accurate electrical power loads for critical systems including airbags, safety devices, instrumentation, etc.
- Cost; reliability of ASM (no brain ASM)
- Consideration of electrical/electronics components in vehicle packaging
- Electro-static charge - proper grounding, diagnostic testing needs to get more sophisticated, higher skilled workers with electronics background needed
- Installation, connection to powered components
- More upgrades, more options, features, smaller pins and more critical sealing required
- Multiplex, less wiring or fiber optics may reduce assembly effort
- Number of switches, relay, components, etc.
- Packaging, easy snap-in connector compatibility system testing with no rectification
- Quality and rework costs
- Relationship to supplier (roles and responsibilities) is major issue
- Self diagnostics - reduction of "no trouble found" defects
- Space

Coordination of Multiplexed Systems

- Multiplex, less wiring or fiber optics may reduce assembly effort
- Multiplexing (2 comments)

Headliner:

- BIW, X,Y,Z coordinate accuracy to match module configuration to ensure proper fit at all areas of the headliner edge mating surface, cross car and fore/aft alignment—major concerns are pillars for rat holes and touch off to glass
- Bulkiness
- Challenges anticipated to remain the same.
- Future design more simple for assembly plant.
- Impact design - more wiring
- Installation, fit
- Maximizing acoustical performance while adding structural and feature content
- No more than today.

- OEM labor reduction resulting from headliners evolving into modular overhead systems

Seats:

- Challenges anticipated to remain the same
- Ease of installation, mating with electrical harness fit
- Fastening, attachment
- Foolproof electrical connectors and proper wire retention to preclude loose wires, cut insulation on wires, and rattle conditions; surface touch off to all critical sheet metal areas to insure proper support of headliner to avoid flutter; foolproof electrical connectors for critical restraint and systems and power controls; controlled hard point dimensions for proper alignment to controls and steering wheel position
- Future design more simple for assembly plant
- Integration of passenger restraint systems
- No more than today.
- Safety requirements will make the seats heavier, and lead to increased mounting challenges.

Discussion

The panel lists alignment with body-in-white most frequently as the challenge presented by modular assembly of instrument panels. The connection/testing of instrument panel electronics was the second most frequent response. Comments regarding modular cockpit assembly were similar to those for instrument panels.

Panelists listed a wide range of assembly plant concerns regarding the installation of door assemblies, electrical/electronic systems, headliners, and seats.

Strategic considerations

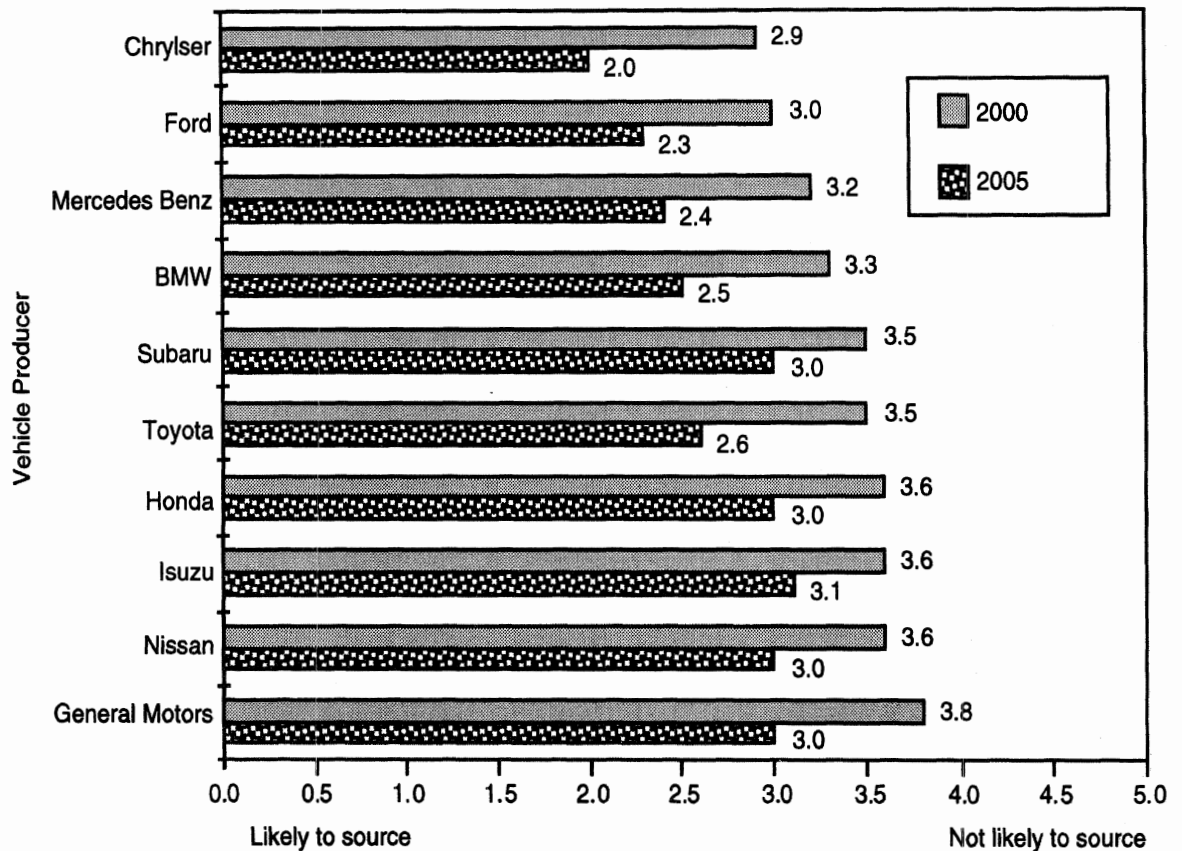
Modular assembly presents a multitude of challenges for manufacturers and suppliers. But the pressure to decrease cost and increase quality will continue to drive the industry to modularization. The ability of companies to move toward simultaneous development will be a critical benefit of modularization. It will be critical for design issues to be resolved early in programs to avoid expensive delays late in programs.

All interior systems are candidates for modular assembly. Examples such as complete inner door modules, fully assembled instrument panels and even cockpit modules should be closely monitored. They may represent the future standard procedure for the industry.

INT-13. Please indicate the likeliness of the following North American vehicle producers to source complete interior systems by 2000 and 2005.

Where 1 = likely to source complete system, and 5 = not likely to source complete system.

**Likelihood of Selected North American Vehicle Producers to Source Complete Interiors:
2000 and 2005**



BMW:

- Need domestic help and support.
- Not likely unless radical change enforced from Germany.
- Tried on the Roadster with limited success.

CHRYSLER:

- Most progressive.
- Need to control quality.
- Receptive to new ways of doing business.
- Stallkamp said no!

FORD:

- Already committed.
- Driving the change.
- Willing to take a chance.

GENERAL MOTORS:

- Likely only to source complete interior systems from Delphi.
- Slow to react - trying to source internally.
- Unlikely, but possible.
- Unlikely to change.

HONDA:

- Conservative.
- Creative changeovers.

ISUZU:

- Hardly likely to matter.
- Isuzu will be gone by 2005.

MERCEDES BENZ:

- Already using cockpit.
- Germanic attitude.
- Looking for partners.
- On their way with AAV, Swatch.
- Studying longer.

NISSAN:

- Cost driven.
- Change from present status unlikely.

SUBARU:

- Gone by 2005.
- Not a major player.

TOYOTA:

- Conservative, comfortable with control.
- Likely only in the event that cost is reduced and system is high quality.
- Will watch Ford.

Other selected edited comments

- 2000 is already past for this decision.
- You forgot VW of Mexico!

Discussion

Panelists rated Chrysler as the most likely to source complete interior systems by 2000. General Motors (3.8), Honda (3.6), Nissan (3.6), and Subaru (3.5) were rated as the least likely to source complete interior systems.

Strategic considerations

Historically, manufacturers have assumed the role of the automotive interiors system integrator. Only recently have suppliers reached the stage where they may be capable of assuming responsibility for an entire system. However, manufacturers may not yet be willing to give complete responsibility to an outside integrator.

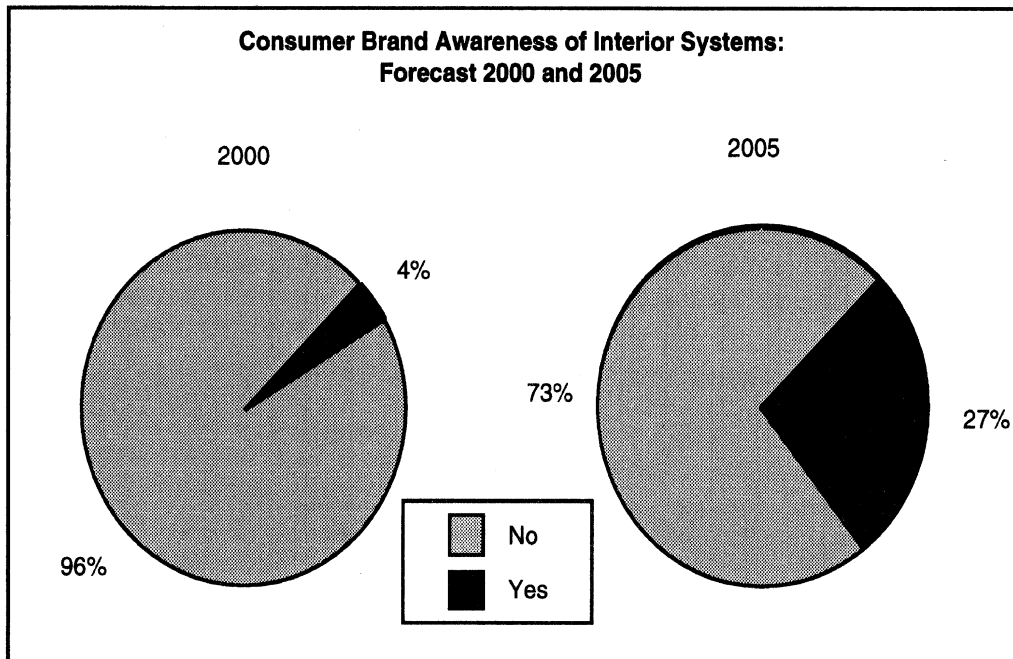
The panel rates companies that are generally viewed as more agile or niche vehicle-oriented as more likely to source entire interior systems. An interesting paradox is presented by the panels rating of Chrysler. The company is viewed by the panelists as the most likely to give

responsibility for an interior to a supplier. The company has a recent history of close partnerships and a willingness to share responsibility with suppliers. Yet comments by Chrysler management seems to indicate an unwillingness to shift responsibility entirely to system integrators.

BMW and Mercedes Benz are also viewed as companies that may be likely to source complete interior systems. This may be due to the low-volume niche vehicles that each company produces at their U.S. located assembly facilities. The potential cost savings presented by a system integrator may make such strategy more viable for lower volume vehicles. A successful systems integration strategy may make a low-volume niche vehicle itself more economically feasible.

In general, the trend to outsourcing of complete interiors must be viewed as a work-in-progress. Experiences in the next few years will certainly influence the long-term trends as both manufacturers and suppliers fine tune their approach to the issue.

INT-14. Brand management has become a critical planning/marketing focus for North American vehicle producers. Will interior system integrators gain brand awareness by the consumer by 2000 and 2005?



Selected edited comments

- Aggressive advertising by suppliers would be required to produce brand awareness. Such advertising would increase piece price, a negative to OEMs. Cost of vehicle makes trial by end users difficult.
- Body by Fisher has left our culture and seats by "interior suppliers" will not come into our culture.
- Customers will have difficulty distinguishing a brand by interior style. Yes, the interior can signal relative price scale, but interiors suppliers will continue to have difficulty communicating a brand image.
- Innovative designs and features will be the "brandable" items that consumers will become aware of. That is one of my future goals - how to "brand" interiors.
- Likely for radios but unlikely for instrument panels, axles, mufflers, etc. as consumers are not interested enough in these components/systems.
- No, unless awareness of industry supply base is expanded to consumer/customer.
- Not likely with present trend. Integrators would have to mount major effort, beginning now to do so. Doubt that this would pay off.
- Only among those in the auto industry or for luxury vehicle interiors where it is a distinguishing selling feature.
- Similar to brand awareness in entertainment (e.g., Bose), interiors systems suppliers may gain brand reputation through advertising and selling interior systems to the general public as part home entertainment package.
- The consumer will continue over the next 10 years to choose vehicles based on manufacturing/ styling/value/NVH/performance; therefore, it is not necessary for UTA/Lear/JCI et al to market to consumers.
- The general public and consumers are just being exposed to the transition of technology and core design from the OEM to the supply base. Over the next 5-10 years, the public will start

to recognize the identity and level of innovation of Lear, JCI, etc. as the source of trim components as well as quality and value added features. It is anticipated that each of the major systems suppliers will eventually be recognized as the previous GM Fisher Body logo of the past. The major obstacle will be the OEMs allowing suppliers to label their parts with logos.

- The question isn't brand awareness on the part of the consumer, but rather brand awareness on the part of the interior systems integrator. Each division and nameplate will have clearer demographic segment targets and it will be up to suppliers to provide interiors with appropriate cues, content, and ambiance. I don't think any customer will say, "Gee, I got the Lear/AI or JCI/Prince interior system in my pickup."
- Will customers recognize future interiors as coming from particular interior systems integration companies? Like Interior by Gucci? If the companies become good enough, yes.
- While brands may be identifiable to OEMs, the public is hardly likely to worry about internal brand publicity.

Discussion

Panelists do not expect interior system suppliers to gain brand awareness with the vehicle purchaser by 2000. However, 27 percent of the respondents do expect these companies to achieve brand awareness by 2005.

Strategic considerations

The automotive industry is in the midst of a brand management revolution. Many manufacturers are working to position their products based on customer lifestyle attributes and receive a premium price through brand identity. The idea of brand identity for interior suppliers raises several interesting questions. It is uncertain whether interior systems can be marketed directly to final customers as an item of differentiation. The added marketing costs necessary to develop such brand awareness will remain a hurdle.

Furthermore, it is unlikely that vehicle manufacturers will, at least initially, desire to share their brand identity with suppliers. Audio systems, tires and batteries are among the few applications where manufacturers have allowed suppliers to gain brand identity. It is apparent, especially by reviewing the selected comments, that some interior suppliers intend to add their product to that short list.

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INT-15. What percentage of North American-produced passenger cars and light trucks will incorporate the following airbags in 2000 and 2005?

Airbag Applications	Median Response		Interquartile Response	
	2000	2005	2000	2005
Passenger cars				
Rear seat occupants	2%	5%	0/5%	5/15%
Side impact	10	28	10/17	20/40
Knee bolster	3	8	1/8	5/18
Inflatable seatbelts	0	3	0/2	0/9
Light trucks				
Passenger side	50%	100%	48/65%	80/100%
Side impact	10	20	5/10	10/30
Knee bolster	2	10	0/8	5/20
Rear seat occupants	0	0	0/0	0/5

Selected edited comments

- Assumptions that airbags will continue to be the “ultimate” solution to occupant safety may not be valid. Alternatives to airbags may appear.
- Current “media furor” could determine future of airbags (type; features; and quality/location).
- Energy absorbing occupant modules and restraints will be functional and cost effective - eliminating the need for airbags.
- I view inflatable seatbelts as an airbag substitute. New technologies in structure crush design as well as other active restraints - (moveable impact rods, etc.) may become a better focus.
- Industry is changing rapidly now - hard to judge based on press (media) and NHTSA.
- Light trucks will follow passenger cars with a slight lag but this gap will close.
- Rear seat airbag penetration may drop due to current issues with front airbags and children (i.e., children in back seat w/o airbag for safety).
- There is always a rush of entrepreneurs and inventors to make a better “mouse trap” and gain financial benefits. The biggest obstacle will always be FMVSS regulations and DOT regulatory control. With the recent exposure of potential flaws in airbags (i.e., small people and children) new ideas will be excessively reviewed by the government, media and the public.
- Unless technology changes significantly, airbags may very well become an option, especially if consumers are allowed to choose. Why have a very expensive option if you can't use it? I have a 7-year-old daughter and I want her nowhere near an airbag until she is in her teens - no matter what the new “suggested” guidelines state.

Discussion

Penetration rates for side impact airbags is forecast to reach 28 percent for passenger cars and 20 percent for light trucks by 2005. Passenger side airbags are forecast to reach 100 percent for light trucks by 2005. Other listed applications are forecast to remain at or below 10 percent by 2005.

Strategic considerations

Until recently, the increased application of airbags was considered a certainty. However, with reports of injuries and fatalities associated with airbag deployment, especially in the case of children and small adults, some doubt now exists. Passenger side airbags are forecast to reach 100 percent penetration for light trucks by 2005. Both driver and passenger side airbags have become standard equipment on nearly all cars, and will soon be standard on all light trucks. However, there appears to be increasing pressure on the part of consumers to have the option to choose airbags, or at least to be offered the option of a switch to turn the airbags off. The panel forecasts little penetration for rear seat or knee bolster airbags. Some increased usage of side impact airbags is forecast as well.

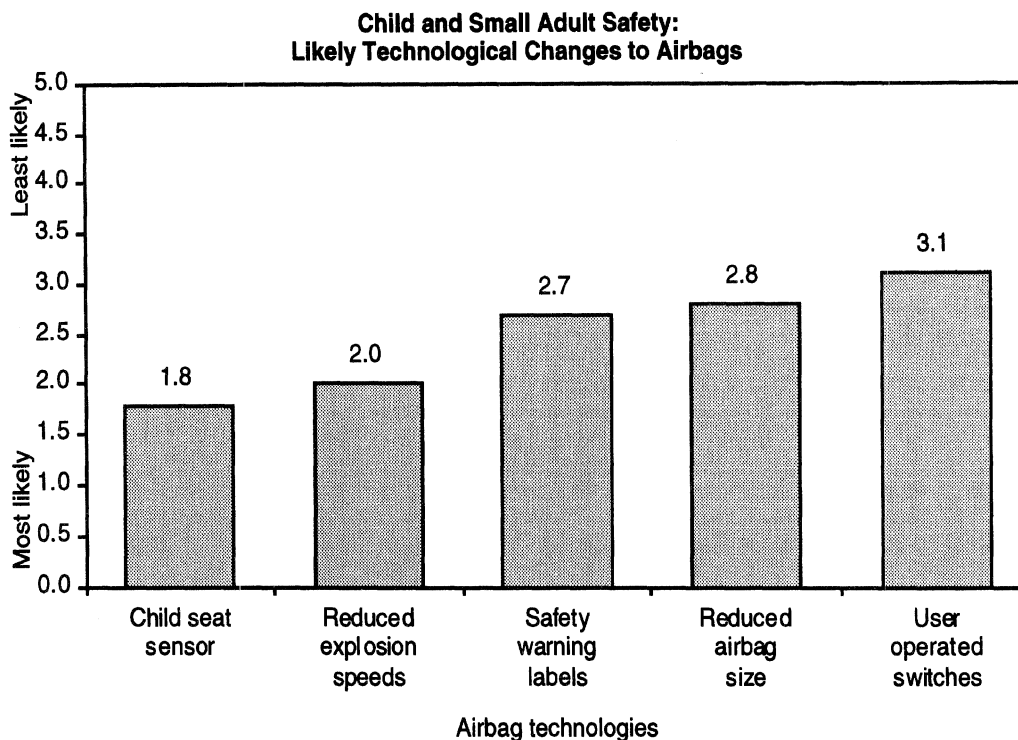
Within the last year, airbags have become a highly volatile topic among media and consumers. Because of recent publicity surrounding airbags, there are likely to be changes in supplemental restraint system design. However, one element of the strategy will not change. Any complete occupant protection system relies on the occupants' willingness to use seat belts. Airbags are not designed to be the solution, only a part of the solution. In any occupant restraint system, an unbelted vehicle occupant will not be as protected as one that is belted.

In recent years, the automotive industry has exerted considerable effort to develop crash dummies and computer modeling systems to represent the human body in crash situations. There is continued effort to more accurately simulate the human body in crash situations. As these techniques are refined, there may be significant implications on future interior design.

The comment "until other technologies appear" is important. The potential for new technology to fundamentally change the entire occupant protection strategy of the industry is significant.

INT-16. With regard to airbags, what technological changes are likely to increase child and small adult safety?

Where 1 = most likely, and 5 = least likely.



Selected edited comments

- None of the above. An alternative solution needs to be found.
- Safety warning labels are not a technology.
- The user operated switches must be easy to use and extremely clear in communicating to the user the state of the system and the conditions that are appropriate for that state to be activated.

Discussion

Child sensors (1.8) and reduced explosion speeds (2.0) are rated as the most likely airbag technology to increase small adult and child safety.

Strategic considerations

See question 17 for strategic considerations.

INT-17. What is the most effective strategy for protecting children and small adults from airbag deployment injuries?

Use of sensors (4 comments):

- Combination of child seat sensors and weight sensitive actuators. (i.e., "smart" airbags)
- Combination weight and distance sensing

Change legislation/regulation (5 comments):

- Legislation requiring passengers under age 12 to be in the rear seat like Europe - vigorous enforcement
- Mandatory seat belts and slower airbag deployment (change standard from full grown man w/o belt to more average sized person w/ belt)
- Reconfigure the standards so that they can effectively protect a belted adult or child, regardless of size. Most likely this would result in a reduced, variable speed airbag.
- Revise 208 standard
- The mistake in airbag regulation was requiring full-passive restraints-which increased airbag aggressivity and narrowed the effectiveness around the 50th percentile. If regulations were amended to reflect the belted condition, and seat belt use was mandatory and enforced, this issue would be mostly solved very effectively. Unfortunately, the solution will probably be technical rather than political, resulting in more costly systems to sense occupants and child seats. While much of the focus has been on children and small women injured and killed by airbag deployment, the implication of narrowing the "safety window" around the 50th percentile dummy is that people in the 80th percentile may not be adequately protected, particularly since the advent of "rip-stitched" seat belts. The shortcomings of the "full passive" policy may be understated.

Reduce/depower airbags (5 comments):

- Driver side: lower deployment speed (change FMVSS to meet only by wearing seatbelt)
Passenger side: lower deployment speed (change FMVSS to meet only by wearing seatbelt)
- Reduced explosion speed based on indicator that child or small adult is sitting in that seat

Other:

- Adjustable seats and/or airbag position to place the equipment in the most optimum position for deployment and protection. The direction of the bag deployment is critical to match the angle and position of the occupant depending on size and shape of the individual, including children.
- Crash avoidance systems
- Do not have airbags—use multipoint belts.
- Each/all use appropriate child seats and/or restraints/belts
- Passive restraint belts in rear seats improved to provide full harness support
- Proper alignment and location
- Put them in child seats located in the rear passenger area. Eliminate lawsuits and pay outs when people do "dumb" things - people need to accept their responsibility for acting irrationally.
- The most cost effective strategy is placement in the rear seat.
- Use seat belts or specialized seating designed for easy removal.

Discussion

Panelists listed changes in regulation/legislation and depowered airbags most frequently as the most effective strategy for protecting small adults and children from airbag deployment injuries.

Strategic considerations

Questions 16 and 17 are intended to gain insight into what technologies are likely to be used to protect children and small adults from airbag injuries, and further, what strategies will be most effective. The industry and government are diligently working to develop the most effective occupant restraint system strategy. Airbag technology is likely to remain an important element of that strategy. However, it has become clear that the government cannot develop regulations based on statistical averages. Vehicle occupants comprise a diverse population. The industry and government must work to achieve the highest level of safety for all occupants.

Panelists rate child seat sensors as the most likely of the listed technologies to increase small child safety. They also expect reduced airbag speed to be a likely response. In fact, many manufacturers plan to incorporate reduced power airbags starting with the 1998 model year. The development of smart airbags will likely become a focal point of airbag technology. Technological solutions may have limitations, especially with regard to cost constraints.

The panel lists a wide range of actions, technologies and strategies for the improvement of child and small adult safety. It is apparent by the wide-ranging, and sometimes contradictory responses that this issue is complex and will be difficult to resolve in the short-term.

INT-18. What new regulations/legislation do you anticipate in the next decade that will impact the interior design of vehicles? Please comment on design changes required. (Please consider possible changes to Federal Motor Vehicle Safety Standards FMVSS 201, 205, 208, 214, and 216) [Underlined headings represent OSAT groupings of common ideas.]

FMVSS 201 - Occupant protection in interior impact:

Design changes required:

Increase energy absorption

- Energy absorption friendly designs
- Improved energy absorption at A and B pillars
- Increased energy absorption material and designs at A-pillar, header and steering wheel
- Increased energy absorption materials/design for rear of front seats
- More composite materials which absorb energy
- More energy absorption volume at A pillar root side, B-pillar, more space/thickness for energy absorption by foam, ribs, etc., Rear of front seats
- More energy absorption volume at A pillar, root, B-pillar
- More space/thickness for all energy absorption by foam, ribs, etc.

Other comments

- Center rear shoulder belt requirement
- Creation of "space safety zones" to provide areas in critical locations surrounding high risk occupant anatomy extremities (i.e., head, chest, etc.) where there is sufficient clear air space for body movement void of any potential surface controls or components which could cause injury. Also, adaptation of a full shoulder harness belt system over both shoulders (i.e., race cars, pilots).
- Hiding of seat belt d-drive anchor and height adjustment mechanism
- I don't foresee any until more data becomes available indicating defense of effectiveness of new head and neck standards and side impact.
- We need to evaluate the need for padding in places where airbags are likely to intervene and prevent contact. It is wasteful and may negatively impact vision.

FMVSS 205 - Glazing materials: To reduce injuries resulting from impact to glazing surfaces, assure visibility:

Design changes required:

- Development of more flexible and hard as glass composite material.
- Development of DLO (daylight operating) surfaces that are pliable/flexible (soft) to absorb impact without distortion of sight lines or images. Additionally, applications of nonfading (noncoloration) materials to preclude aging disfiguration and environmental degradation of clear vision properties.
- I don't think it's a matter of design but more a matter of materials performance - e.g., a hard, impact resistant, clean plastic is needed to replace glass.
- Increased use of glazing in windshield
- None likely.

FMVSS 208 - Occupant crash protection:

Design changes required:

- Introduction of innovative materials

Pretensioners for seatbelts (2 comments)

- Pretensioners
- Pretensioners/elimination of dangerous “rip-stitching” in seat belts - similar to Europe

Personalization (2 comments)

- Pre-selection of personalized settings at point of purchase to major user needs
- Shift from averaging to personalization

Other comments

- Affordable technology for occupant detection
- Do not agree with rear airbags. Again, reconfigure the standards.
- Incorporate occupant protection into component design, eliminating redundant systems (i.e. airbags).
- More space/thickness for all energy absorption by foam, ribs, etc.
- Optimum use/placement of energy absorbing polyurethane foams
- Rear seat airbag
- Seat design revisions

Smart/reduced power airbags (9 comments)

- “Smart” airbag sensors
- Ability to vary airbag size or inflation rate based on size of occupant
- Current public outcry will result in either; European style belted test procedures or (more likely) additional technology to tailor airbag aggressivity based on occupant size and position.
- Depowered airbag (change FMVSS 208, to seatbelt weaved case only)
- Depowered airbags, two stage airbags, suppression for children and child seats
- Development of “smart systems” that are adjustable and reconfigure their properties to match the intended target attribute (i.e., size, weight, seating position, etc.)
- Occupant detection, suppression for child seat
- Seat sensors - child and child seat

FMVSS 214 - Side impact protection:

Design changes required:

- Continued “dis-harmonization” with European side impact
- Increased lateral body structure and door interlocks
- Less aggressive front ends of vehicles
- More energy absorption in door inner, stronger frame structure
- Non airbag technology alternatives
- Plain side wall, clean surfaces without potentially dangerous hardware that could cause bodily harm upon impact. Redesign of door inner hardware (i.e., glass tracks, handles, etc.) that could penetrate side wall trim panels upon impact.
- Side bags in smaller passenger cars, stronger doors, faster sensing for rear door side bags

- Side bags in smaller passenger cars
- Stronger door beams
- Stronger doors, faster sensing for rear door side bags

FMVSS 216 - Roof crush resistance:

Design changes required:

- FMVSS 216 is expected to be applied to additional vehicle types such as light trucks.
- Incorporation of composite materials to strengthen the green house with light weight structures with minimal cross section area to increase visibility. Development of a roof safety cage (i.e., race cars) out of composites.
- Layer A, B pillars
- Roll cage designed into vehicle structure
- Stronger pillars

Environmental:

Recyclability

- A contrarian view, with no federal or state driven recycling is anticipated- legislation/regulation will need to be economically justified.
- Acceptance of energy recovery as a way to recycle plastics/synthetics; easier disassembly of major systems - e.g., instrument panels, seats, headliners and doors - and fewer different materials.
- Anticipate fewer changes in materials specified by OEM and more material commonization across products.
- Anticipate recycling requirements; design for disassembly, commonization of material families within components.
- Emphasis on environmentally friendly products expected; vehicles will need to be easily dismantled for recycling.
- Major components will need to be recyclable, and designed for disassembly.
- Materials must be easy to reuse.
- Recommend recyclability be legislated now with a defined date for enforcement in the future to allow development time; expect fewer changes in materials specified by OEM and more material commonization across products.
- Required recyclability of the vehicle much like Europe is expected, except lower percentage; major components, i.e., instrument panels, headliner, trim, recyclable and designed with one material or compatible materials.

Other comments

- Anticipated fleet vehicle pollution standards that mandate alternative fuels; lighter weight structures and materials.
- Anticipate tightened air quality standards; reduced applications of painting and more usage of molded in color. Use of less toxic materials in manufacturing and life cycle accounting of vapor emissions.
- Environmental issues will force recyclability.
- Fuel economy concerns will cause increased use of composite materials.
- Greater emphasis on A/C system impact on mileage and pollution, external and internal to vehicle; New "medium" to replace R-134A; development of in-car filtration.

- Increased fuel economy standards will lead to increased application of more complex structure, lightweight materials.
- No legislation or regulations but fleet, and to a lesser degree individual, purchases influenced by environmental friendly attitudes

Intelligent Transportation Systems:

- Anticipate commonization of standards for ITS.
- Anticipate trucking industry standards and usage; highway compatible designs.
- Expect less regulatory actions and more industry driven applications toward self governed concepts; interactive design modules to link the supplier technology base while protecting proprietary concepts.
- ITS won't happen unless governments decide to invest in infrastructure - not likely.
- Mandate equal responsibility for ITS for the construction and planning of road systems; safer highways will allow resources to be applied to other critical areas. Traffic separation for oncoming vehicles reduced to focus on head-on accidents. Control cross road intersections to reduce the focus on side impact. Speed restrictors (electronically) needed on highways to reduce the need for high speed crash containment. Speed zone control via road surface frequency generating material or surfaces (i.e., speed strips, surface etching, etc.) could force reduced speed limits.
- More focus on the user-interface is needed. Systems are being technology driven, not needs driven.
- None - let competition set the pace; develop highway and vehicle compatibility in a coordinated environment between OEM and government.
- Precompetitive, preregulation industry/government partnerships are the way to pave the way for ITS.

Other safety concerns:

- High temperature standard for the desert in the summer needed (~175°F); change in plastic material that meets requirement
- Higher interior temperatures (175°F) is a concern; plastic materials specified
- Increased passenger protection needed—overall, more effective airbags—greater use of airbags
- Increased requirements for fire retardancy necessary; material specs require FR materials
- Need reconfigurable displays
- Occupant protection important; head impact, rollover, side impact, offset testing will combine to create a drastically new design and manufacturing environment
- Offset impact testing will become a standard; changes in front structure needed for offset
- Rear vision systems; must eliminate blind spots in side mirrors
- Revisit laws in relation to reconfigurable displays
- Safety in general; passenger side airbags for light trucks - hands free cellular phones, heads up display
- Security or anti-theft regulation
- Use of damage resistant structure/material for insurance reasons; use of stronger, elastic exterior materials

Discussion

The panelists list a wide variety of legislation/regulation activity. Safety related issues represent a significant portion of the responses; however, recycling is also mentioned frequently.

Strategic considerations

The breadth and depth of the panelists' comments warrant special consideration. We strongly recommend careful review of the comments. The responses suggest a need for industry and government to work closely to develop guidelines for an effective occupant protection system that meets the needs of a diverse population.

Intelligent transportation systems present an opportunity for industry and government to apply the lessons learned from the recent airbag problems. The ability of all interested parties to work together to develop a safe, cost-effective strategy for ITS implementation may greatly reduce future problems for ITS planners and users alike.

One final note: Industry and government can develop what may be an excellent occupant protection system, but without proper usage by drivers and occupants, no system will be optimally effective. Considerable effort to increase seat belt usage should be an integral part of any occupant protection plan.

INT-19. Please indicate in what year the following options will see limited application ($\approx 5\%$) in passenger cars or light duty trucks, and what year the technology will see a 25% application rate. Also, please estimate the highest purchase price in 1996 dollars which will permit a 25% passenger car penetration rate. Recall that an average vehicle costs approximately \$20,000 in the 1996 U.S. market.

Technology	Median Response			Interquartile Range		
	Limited application	25% application	Price for 25% application	Limited application	25% application	Price for 25% application
Active controlled seat suspension	2000 yr.	2010 yr.	\$ 200	2000/2002 yr.	2005/2011 yr.	\$150/200
Air-cooled seats	2000	2007	100	2000/2004	2005/2013	93/138
Digital signal processing (DSP) systems integrated into audio systems	2000	2006	150	2000/2000	2005/2010	93/225
Head up display (HUD)	2000	2005	140	1996/2000	2005/2009	100/200
Mobile office accommodations (PC, Fax, etc.)	2000	2005	250	2000/2000	2005/2010	200/500
Video (for passenger)	2001	2010	300	2000/2005	2005/2018	200/500
Anti-theft systems:						
Coded credit card for entry/ignition	2000	2005	65	2000/2003	2005/2010	50/100
Passive keyless entry/ignition	2000	2005	100	2000/2002	2005/2010	50/100
Voice recognition	2005	2010	100	2002/2006	2010/2015	100/131
ITS systems:						
Adaptive cruise control	2001	2010	225	2000/2005	2008/2010	150/400
Collision warning systems	2003	2010	300	2000/2005	2005/2015	200/500
Automatic toll collection	2000	2010	50	1999/2002	2002/2010	50/100
Navigation	2000	2010	425	1997/2002	2006/2010	200/500
In-vehicle message system	2000	2010	200	2000/2004	2005/2010	100/400

Selected edited comments

- Active controlled seat suspension, mobile office accommodations, video and collision warning systems will never reach 25% application. With regard to ITS Systems, collision warning systems will never reach 25% application.
- All of the features are desired by the customer but not always needed. There are always a number of buyers that will purchase any new gimmick just to say they have the latest. The added cost of these options may be offset by deleting other options. If it is a choice between HUD and FM stereo, the sound system will prevail.
- I believe the introduction of these features is much more cost effective, as vehicle manufacturers depend on system suppliers instead of themselves.
- Many features not legislated or consumer driven will not reach 25% use. Increased cost due to electronics and complexity drive long term backlash to simple/cheap transport.

- Navigation systems will end up like cellular phones - not integrated into the vehicle, but carried by the operator.
- Today's cost consciousness will carry forward. 1) Only those systems with tangible benefit or perceived benefit will "make the cut." 2) "Personal" electronics are progressing much faster than car makers capability to incorporate them. Tomorrow's PC's/FAX modems/mobile phones/ pagers will move from "laptop" to "palmtop." Carmakers also will be unable then, as now, to find room for all this stuff on their instrument panels. 3) This technology held up as much by liability concerns as technical capability.
- Video (for passenger): too distracting. ITS Systems: There is no need for adaptive cruise control, the current system is OK.
- Where are reconfigurable displays and voice 'displays'?

Discussion

Panelists forecast each of the listed technologies to reach limited application in the coming decade. The listed ITS technologies are not forecast to reach 25 percent application until 2010 and beyond.

Strategic considerations

The interior of a vehicle presents opportunity for increased options and features. However, cost remains a major barrier to the introduction of new features. The panel forecasts limited application for all of the listed features within the next 3 years. Only a few of those features are viewed as likely to see 25 percent or greater application in the coming decade.

There is little doubt that technology exists to bring each of the listed options to market in the near future; however, the challenge to manufacturers and suppliers is to develop features that address a specific need in a cost-effective manner. Panelists were asked to give estimates for the price that would allow for each option to reach 25 percent penetration. The total price for the listed options is approximately \$2500. At a time when some suggest the industry is facing an affordability challenge, new options may be difficult to sell unless the consumer sees them as providing high value.

Recently, in-vehicle navigation systems have experienced increased usage in Japan. However, for several reasons, acceptance of these systems has been much slower in the U.S. This lag in penetration for in-vehicle navigation systems may have an interesting result. Hand-held navigation systems are becoming a viable alternative to in-vehicle systems. Much like the hand-held cellular phone has replaced the permanently installed cellular phone, the hand-held navigation system may limit the potential market for in-vehicle systems. This raises a broader issue with the expected blending of consumer and automotive electronics. The disappearing boundary between these areas could have a profound impact on the automotive electronics. The industry is currently wrestling with such critical issues as open architecture and consumer cost/benefit tradeoffs.

INT-20. Please forecast the total domestic and import U.S. passenger car and light truck market in percent of the following factory-installed comfort and convenience items in 2000 and 2005.

Comfort Features	Passenger Cars				
	Est.	Median Response		Interquartile Range	
	1994 MY*	2000	2005	2000	2005
Anti-theft	31%	50%	75%	49/50%	60/90%
Automatic climate control systems	18	20	30	20/25	25/40
Car phone	N/A	10	20	5/15	10/38
CD players	9	20	50	18/40	30/75
Dual climate control systems	N/A	10	20	5/10	15/25
Incoming air filters	N/A	10	30	5/20	20/45
Keyless entry	28	40	60	35/50	50/75
Leather interiors	21	23	25	20/25	24/30
Steering wheel-mounted controls	N/A	10	20	10/12	20/30
Sunroof	25	25	30	25/29	26/35
Tilt/Telescopic steering columns	80	80	85	80/82	80/90
Trip computers	8	10	18	10/10	15/20

Comfort Features	Light Trucks				
	Est.	Median Response		Interquartile Range	
	1994 MY*	2000	2005	2000	2005
Anti-theft	4%	20%	50%	19/26%	30/75%
Automatic climate control systems	2	8	15	5/10	10/20
Car phone	N/A	5	10	5/10	10/20
CD players	4	10	23	8/20	17/50
Dual climate control systems	N/A	5	6	1/5	5/10
Incoming air filters	N/A	5	18	4/11	10/25
Keyless entry	14	20	40	20/25	30/50
Leather interiors	7	10	10	8/10	10/15
Steering wheel-mounted controls	N/A	5	10	5/10	10/15
Sunroof	1	5	5	2/5	4/10
Tilt/Telescopic steering columns	70	75	80	70/80	70/81
Trip computers	N/A	5	10	5/7	10/15

* Source: Automotive News 1995 Market Data Book

Selected edited comments

- Air purifiers should be added to the list of features.
- Car phones face a major threat from the small personalized hand held cell phones which people can carry with them. Why invest in a stationary phone mounted in the car when you can have a phone which you can carry anywhere? Having a cell phone in your hand when returning to your vehicle is a valuable self protection device to immediately call 911 if you suspect trouble when you reach your vehicle.
- Most current systems will experience zero growth except: 1) safety, 2) anti-theft, 3) performance, 4) cost/assembly savvy.
- Steering systems/telescoping could rapidly decrease if drive by wire is implemented.
- The success of immobilizers in Europe will drive the antitheft market in NA.
- Trucks will continue to be more car-like in their adoption of features. The clean air movement would spark a rapid growth in unknown systems like incoming air filters.
- What about reconfigurable pedals for comfort and safety (e.g., to allow more distance from the airbag for short drivers)?

Discussion

Panelists forecast adjustable steering columns (85 percent), anti-theft devices (75 percent), keyless entry (60 percent) and CD players (50 percent) to gain significant application rates for passenger cars by 2005. The same features are forecast to see growth in light trucks, but to a lesser degree. Car phones, dual climate control systems, incoming air filters, leather interiors, steering wheel-mounted controls, and trip computers are forecast to reach penetration rates of 25 percent or less for passenger cars and light trucks.

Strategic considerations

Consumers are being offered a wide variety of interior-related options today and more will become available in the years ahead. The challenge for manufacturers and suppliers is to offer comfort and convenience items that present high-perceived value to the customer.

All of the listed components are forecast to see increased application in the coming decade. Compact disc (CD) players and anti-theft devices are forecast to experience the largest growth. CD players represent a perceived value by many customers. To many, the increased sound quality offered by CD players makes the added cost justifiable. Anti-theft devices also offer significant value to customers. However, anti-theft devices present an interesting dilemma. Technology provides the ability to disable a vehicle in time of emergency or to prevent theft. The introduction of electronic theft protection strategies may make vehicles more secure, but strangely enough, in certain situations, it may be placing the occupants at greater risk. In some cases, car-jacking has been the criminals' response to the ability of a car to be electronically disabled.

In many of the listed technologies electronics will increasingly become the key enabler. It is imperative for interior suppliers to become electronically literate—at least to the point where they can effectively interface with the electronics industry. Electronics may become the critical technology for many systems, placing the electronics supplier in a position to assume the lead role as the system integrator.

INT-21

What percentage of total vehicle cost of North American-produced passenger cars will interior electronic componentry comprise currently and in 2000 and 2005?

Electronic Componentry as a Percent of Cost						
	Median Response			Interquartile Range		
	Current Est.	2000	2005	Current Est.	2000	2005
Compact	10%	15%	15%	10/11%	10/15%	12/20%
Midsized	12	15	18	11/15	15/20	15/20
Large/luxury	20	20	24	15/20	20/25	20/29

Selected edited comments

- I expect the cost level to remain approximately the same as today with a functional increase of 4 to 5 times.
- Cost of electronics cannot plummet unless the car electrical/electronic systems becomes more like a personal computer. Vehicle electronics need to be standardized.
- Costs of electronics are plummeting, while applications are rising, netting little if any, change in overall cost.
- Electronic cost increases will be primarily regulatory. Feature content increases will be offset by cost reduction/integration - except on luxury vehicles.
- The buyer does not have much choice on many electronics but will resist higher cost for vehicles which do not present more value for the extra cost. Optional electronics will be subject to cost constraints (purchase power) requiring other optional equipment deletion or downgrade to fund added cost of electronics.
- There will be a substantial addition of features and functions at no cost increase
- While cost concerns are well taken, I believe that additional electronic features, e.g., navigation, 2-way communication, enhanced (DSP, overhead) audio and displays will be come more popular in midsized and upscale vehicles.

Discussion

Panelists forecast interior electronic componentry to increase as a percent of total vehicle costs.

Strategic considerations

The panels forecast of 15-24 percent of total vehicle cost for interior electronic componentry appears to be rather high, especially when compared to the *Delphi VIII: Forecast and Analysis of the North American Automotive Industry, Volume 2: Technology*. We suspect that the Interior Delphi panelists may have interpreted the question as cost of total vehicle electronics.

TECH73. What percentage of total vehicle cost of North American-produced passenger cars will electronic componentry comprise currently and in 2000 and 2005?

Electronic componentry as percentage of total vehicle cost	Median Forecast			Interquartile Range		
	Current Est.	2000	2005	Current Est.	2000	2005
	15%	18%	20%	10/20	14/25	17/30

Nonetheless, as percentage of cost, electronics—for both total vehicle and interior—is expected to increase substantially in the coming decade. This forecast increase is in spite of a general decline in the cost of electronic components per function provided. The increased cost will most certainly be due to the amount of electronics added to the vehicle. Questions 13, 14, 18, 19, 20, and 21 address potential components and options that may increase the level of electronics content in future vehicles. The responses for each of these questions should be reviewed in the context of affordability and overall customer need.

INT-22. What percentage of North American-produced passenger cars will utilize at least one multiplexed (MPX) power subsystem by 2000 and 2005? Please estimate for current vehicles.

Passenger Car Usage of Multiplexed Systems						
	Median Response			Interquartile Range		
	Curr. Est.	2000	2005	Curr. Est.	2000	2005
Multiplexed power subsystem utilization						
Compact	0%	5%	10%	0/0%	0/10%	5/20%
Midsize	2	10	20	0/8	5/18	12/51
Large/Luxury	9	20	48	5/20	15/25	20/81
5 power subsystem utilization						
Compact	0%	1%	5%	0/0%	0/3%	0/7%
Midsize	2	10	15	1/5	2/13	5/25
Large/Luxury	5	15	20	3/9	5/18	15/35
10 power subsystem utilization						
Compact	0%	0%	0%	0/0%	0/0%	0/1%
Midsize	0	3	5	0/1	0/5	0/10
Large/Luxury	1	5	10	0/3	0/8	5/15

Selected edited comments

- MPX is a standard design technique for vehicles 2000 and beyond except for basic transportation vehicles.
- This assumes (MPX) means data bus control of a subsystem not data bus control of a power switch such as a head lamp relay.

Discussion

Multiplexed power systems are forecast to experience significant penetration in the coming decade. The panelists forecast MPX power subsystem utilization in large/luxury cars to reach nearly 50 percent by 2005. However, the wide interquartile ranges indicate some uncertainty regarding the future of MPX systems.

Strategic considerations

There appears to be a great deal of uncertainty on the part of the panelists regarding the future of multiplexed power subsystem usage. Although panelists agree that there is limited usage of MPX currently, there appears to be a great level of uncertainty about the future of such systems. The exceptionally wide interquartile ranges, especially for 2005 suggest differing levels of expected application and/or different strategies by the various manufacturers.

The advantages of weight reduction and reduced space requirements may be offset by concerns over reliability and cost. Many companies are currently implementing MPX in new vehicle programs. The next five years should reveal significant insight into the future of multiplexed subsystems. Obviously any supplier affected by electronics technology should track developments closely. This is a very pervasive issue and the direction is uncertain at this time. In the longer term, however, it appears that multiplexing will become a standard part of the automotive electronics agenda.

INT-23. What percentage of multiplexed systems will utilize a fiber optic control bus technique rather than wire control bus by 2005?

	Median Response	Interquartile Range
Multiplexed systems	2005	2005
Utilizing fiber optics	15%	10/35%

Selected edited comments

- DAB audio system/vehicle computer will drive this market.
- High degree of system labeling commonization like SAE J 1939 could drive fiber optics.
- The push to be first to market will drive the up-level luxury segmentation to promote usage. Also, there are certain advantages for styling and design to warrant this technology.

Discussion

Panelists forecast 15 percent of MPX systems will use fiber optic control bus techniques by 2005.

Strategic considerations

There is substantial uncertainty regarding the cost-effectiveness of fiber optic control busses for multiplexed system applications in automobiles. Interior lighting may be the initial area where fiber optics see application in multiplexed systems, although the primary use of fiber optics in lighting may well be to distribute light from a central source. One fundamental problem with fiber optic data transmission is that the signal in most cases must be converted from electrical to optical and back again. This appears to be the root cause of the cost issue. Still, with the significant potential advantages of fiber optics and the speed with which new technology is being developed, it is imperative to monitor developments closely. However, current demands for data transmission may not justify the added cost of fiber optics for some time.

INT-24. How many rotating and linear electric motors will North American-produced passenger cars have in 2000 and 2005? Include door locks, mirrors and trunk lid actuators. Please provide your estimate for current vehicles.

Passenger cars having rotating and linear electric motors	Median Response			Interquartile Range		
	Current Est.	2000	2005	Current Est.	2000	2005
Compact	5	10	10	3/8	6/10	10/12
Midsize	10	15	19	10/14	13/17	16/20
Luxury	20	23	28	18/20	20/25	22/33

Selected edited comments

- Assumes one motor for each window, door lock, trunk, seat, sunroof.
- Believe there will be technology substitutions, thus micromotor usage will not grow.
- Fewer motors will be used to perform more functions. Multifunctional power sources will service many operations. Vacuum systems will become more flexible and do the work of motors.
- My estimates include all forms of electric power servo systems which will replace mechanical.

Discussion

Compact cars (10), midsize (19), and large/luxury (28) are all expected to see increased usage of electric motors by 2005.

Strategic considerations

The use of electric motors is forecast to grow for each of the listed passenger car segments. This forecast suggests added cost and weight to future vehicles due to the increased number of electric motors. The automotive industry already faces an affordability challenge, and potential weight constraints. Features that add weight and cost will be closely scrutinized to determine value to the consumer. Of course, another key issue is the extent of system-level tradeoffs with greater use of electric motors. Modern small motors can be quite inexpensive in volume production and, with their use, yield lower total system cost versus traditional technology.

The affordability issue may present a situation where price-sensitive, entry-level compact cars will see a limited increase in the number of convenience options offered, therefore directly limiting the opportunity for electric motor applications. Conversely, a much less price-sensitive segment, such as luxury cars, may experience growth rates even higher than those forecast.

INT-25. What percentage of North American-produced passenger cars will be equipped with these electric motor-driven devices by 2000 and 2005?

Electric Motor-Driven:	Median Response			Interquartile Range		
	Current Est.	2000	2005	Current Est.	2000	2005
Power windows	50%	63%	80%	50/60%	59/75%	65/80%
Power door locks	63	75	83	48/66	55/75	74/90
Powered door closer/opener	1	2	5	1/1	2/5	4/10
Rear seat sunshade	0	1	5	0/1	1/2	3/5
Seat						
Driver seat	30%	35%	50%	20/30%	25/40%	38/53%
Passenger seat	10	15	28	5/15	10/20	20/30
Seat lumbar actuator	5	10	16	5/10	10/18	10/31
Seat recliner	10	15	20	8/10	10/20	12/30

Selected edited comments

- Believe there will be technology substitutions, thus micro motor usage will not grow.
- Economics of scale will push many features to be lower cost and simplify assembly by proliferation of usage. Sometimes it is better to give away an option on the small volume, low end applications to reduce in plant complexities.
- Most of these items are "mature", and growth would be demographically rather than technologically driven. (i.e., aging population with larger, more well appointed cars).
- By 2005, there will be a great deal of awareness regarding harmful UV radiation with children being in rear seats, there will be more demand for rear seat sun shades, especially in family vehicles.
- Smart drive systems, i.e., one motor - many functions, could drive actual motor number decline (UTA system).

Discussion

Power door locks (83 percent) and power windows (80 percent) are forecast to see widespread application by 2005. Of the other listed electronic devices, only power seats (50 percent) is forecast to see penetration rates at or above 50 percent by 2005.

Strategic considerations

The panel forecasts increased application for each of the listed features, suggesting continued price pressure on future vehicles. However, in many cases at the system level, the added content may actually have a minimal effect on cost. Manufacturers are continuing to include the listed features as standard equipment, especially on upscale models. This is in large part due to customer expectations. The industry faces an interesting challenge. Consumers are requesting increased levels of convenience features, while concomitantly becoming increasingly concerned with affordability.

This dilemma presents the opportunity for the development of alternatives to individual motors for each application or significant reduction in motor/systems cost. Much work is being done to develop alternative power methods. This work should be watched closely.

INT-26. What percentage of North American-produced passenger cars and light trucks will have the following integrated controls currently and in 2000 and 2005?

Integrated Controls						
Passenger Cars	Median Response			Interquartile Range		
	Current Est.	2000	2005	Current Est.	2000	2005
Integrated radio and climate controls						
Compact	3%	5%	10%	1/5%	2/10%	5/11%
Midsize	5	10	15	3/6	6/11	10/21
Large/luxury	5	13	20	5/11	8/16	14/30
Integrated climate control cluster						
Compact	0%	1%	5%	0/0%	0/5%	5/8%
Midsize	1	5	10	0/4	3/8	7/15
Large/luxury	4	10	15	0/5	5/13	10/28
Integrated radio, climate control and instrument clusters						
Compact	0%	0%	0%	0/0%	0/2%	0/5%
Midsize	0	2	5	0/2	0/5	2/9
Large/luxury	0	5	10	0/2	2/6	5/15

Integrated Controls						
Light Trucks	Median Response			Interquartile Range		
	Current Est.	2000	2005	Current Est.	2000	2005
Integrated radio and climate controls						
Compact	0%	0%	5%	0/0%	0/2%	2/8%
Midsize	2	5	9	0/3	2/5	5/12
Large/luxury	5	10	14	0/5	5/10	10/20
Integrated climate control cluster						
Compact	0%	0%	5%	0/0%	0/3%	1/6%
Midsize	0	3	7	0/2	0/5	2/10
Large/luxury	0	5	11	0/5	4/11	7/20
Integrated radio, climate control and instrument clusters						
Compact	0%	0%	2%	0/0%	0/0%	0/5%
Midsize	0	0	5	0/0	0/3	0/7
Large/luxury	0	4	8	0/0	0/6	5/10

Selected edited comments

- All designs will be integrated by 2005.
- Not sure what benefits are to customer or OEM. Can the customer differentiate?
- Substantial design change and cost reduction will impact product families.

Discussion

The panel forecasts no significant penetration of the listed integrated controls. However, of the listed controls, the panel forecasts integrated radio and climate controls to gain the highest penetration in the coming decade.

Strategic considerations

The integration of control panels presents opportunity for design and styling changes, as well as potential cost reduction. Modularization or integration of climate control, instrumentation, and radio controls may allow for reduced cost through increased application of system engineering.

A key issue will be trends in system architecture and the potential (even likely) emergence of a "plug and play" strategy. This area, in general, is one that is ripe for innovation and must be tracked closely by potentially impacted suppliers.

INT-27. What percentage of North American-produced passenger cars and light trucks will have the following instrument display formats in 2000 and 2005?

Instrument Display Formats						
Passenger Cars	Median Response			Interquartile Range		
	Current Est.	2000	2005	Current Est.	2000	2005
Analog						
Compact	100%	95%	92%	95/100%	93/100%	85/96%
Midsize	90	90	80	90/95	84/90	75/88
Large/luxury	80	80	70	80/88	70/80	55/80
Digital						
Compact	0%	5%	5%	0/5%	0/7%	2/10%
Midsize	10	10	15	5/10	10/15	10/20
Large/luxury	15	20	25	10/20	10/25	10/30
Electroluminescent						
Compact	0%	0%	0%	0/0%	0/0%	0/5%
Midsize	0	0	8	0/0	0/5	5/10
Large/luxury	5	10	15	0/10	10/15	10/20
Driver selected digital/analog						
Compact	0%	0%	0%	0/0%	0/0%	0/0%
Midsize	0	0	2	0/0	0/0	0/5
Large/luxury	0	5	7	0/0	0/5	4/10

Selected edited comments

- Affordable cost versus perceived value will be an issue.
- Vehicles will be 100% digital and electroluminescent by 2005.
- Depends more on styling choices than technology.
- Digitally simulated/emulated analog displays generally aren't very good.
- Displays are driven by degree of multiplexibility, timing of GPS (maps) integration and consumer preference. Anticipate a change from analog to digital (i.e., baby boomers to generation X).

Instrument Display Formats						
Light Trucks	Median Response			Interquartile Range		
	Current Est.	2000	2005	Current Est.	2000	2005
Analog						
Compact	100%	99%	95%	98/100%	91/100%	87/99%
Midsize	100	95	90	97/100	91/95	85/95
Large/luxury	95	90	83	91/98	85/92	79/98
Digital						
Compact	0%	1%	5%	0/0%	0/5%	1/8%
Midsize	1	5	8	0/3	3/9	4/14
Large/luxury	5	10	10	2/9	6/10	10/15
Electroluminescent						
Compact	0%	0%	1%	0/0%	0/0%	0/3%
Midsize	0	0	2	0/0	0/2	0/5
Large/luxury	0	3	5	0/0	0/5	4/13
Driver selected digital/analog						
Compact	0%	0%	0%	0/0%	0/0%	—%
Midsize	0	0	0	0/0	0/0	0/1
Large/luxury	0	1	3	0/0	0/5	0/5

Selected edited comments

- All vehicles will use digital - outward display will vary based on car personality.
- Options other than analog most likely high end options for SUV and van market. Pickups will remain analog.
- Need to define electroluminescent—is it electric lights, fluorescent paint or electric diode resistors at each digit?

Discussion

According to the panelists' forecast, analog instrumentation will remain the predominant display format in the coming decade. However, digital and electroluminescent instrumentation are forecast to see increased application.

Strategic considerations

The panel forecasts markedly different penetration rates for the listed vehicle segments. The compact segment, being the most price sensitive, is expected to see limited application of digital display formats, and no electroluminescent displays. Conversely, the electroluminescent display format is seen as gaining increased penetration in the luxury segment. The analog display is expected to remain the format of choice in light trucks.

Digital displays have been available for several years, but have gained limited customer acceptance. However, as "generation X" becomes a larger portion of the new car buying pool, this may change. There is some indication that younger buyers, having grown up with digital clocks and computers may be more willing to accept vehicles with digital readouts.

A very important issue is the concept of reconfigurability. Display technology is being developed that will permit the display format to be defined by software which suggests that consumers might be able to design their own format and change it if they desire.

INT-28. Please indicate the percent of North American-produced passenger cars and light trucks with generic instrument panel ports in 2000 and 2005.

Percent of NAPPV with generic instrument panel parts	Curr. Estimate	Median Response		Interquartile Range	
		2000	2005	2000	2005
Passenger car	0%	1%	10%	0/5%	5/15%
Light truck	0	0	5	0/2	5/10

Selected edited comments

- By 2005 industry economies will shift industry to point of sale installations - tailored audio/panel communications modules.
- These may be common within OEMs, but difficult to do across OEMs even with first-tier concentrations.

Discussion

Panelists forecast light vehicles equipped with generic instrument port panels to account for 5 to 10% of total light vehicle sales by 2005.

Strategic considerations

See question 29 for strategic considerations.

INT-29. What are the barriers to generic instrument panel ports for consumer electronics?**Selected edited comments**

- A standard data-bus communication protocol (i.e., CAN vs. RS232) between the automotive world (CAN, A1850) and consumer electronics (RS232)
- AC/DC conversion, size of constraints, lack of demand, enough space in dashboard
- Need a uniform standard for part commonality
- Lack of a standard across brands
- OEM and supplier preference and inability to agree, lack of interest among OEMs
- Software
- This is a bad idea trying to be recycled again. Unique vehicle packaging precludes this happening to a significant extent.
- Vehicle manufacturer wants the mark-up of a device on board vs. the lack of profit of a plug and play.
- Vehicle usage and configuration of sensors
- Uncertainty as to who sets the standards, SAE or consumer electronics, or someone else totally? Negotiating and coming to agreement will be the hardest task towards making this workable.

Discussion

Panelists present a wide variety of barriers to the acceptance of generic instrument port panels. Those barriers most frequently mentioned include standardization between vehicle manufacturers, bus communication protocol, and the ability of the manufacturers to control profits.

Strategic considerations

Generic instrument panel ports present interesting opportunities and challenges for the industry. These ports would allow for electronic componentry to be updated, either through software upgrades or replacement of components throughout the life of a vehicle. These ports could also act as a point of entry for a wide variety of consumer electronics manufacturers to gain access to the automotive market. Companies offering such accessories as GPS systems, communication systems and other rapidly evolving electronics could potentially offer consumers increased levels of performance and choice for dealer or aftermarket installation.

Industry-wide acceptance of generic instrument panel ports will likely be slow for several reasons. First and foremost, manufacturers strongly desire to maintain uniqueness with regard to competition. Generic port panels are perceived by many as a direct threat to that uniqueness. Second, manufacturers may not be willing to relinquish the profit margins associated with original equipment, and may therefore fight any effort to shift installation points away from their control.

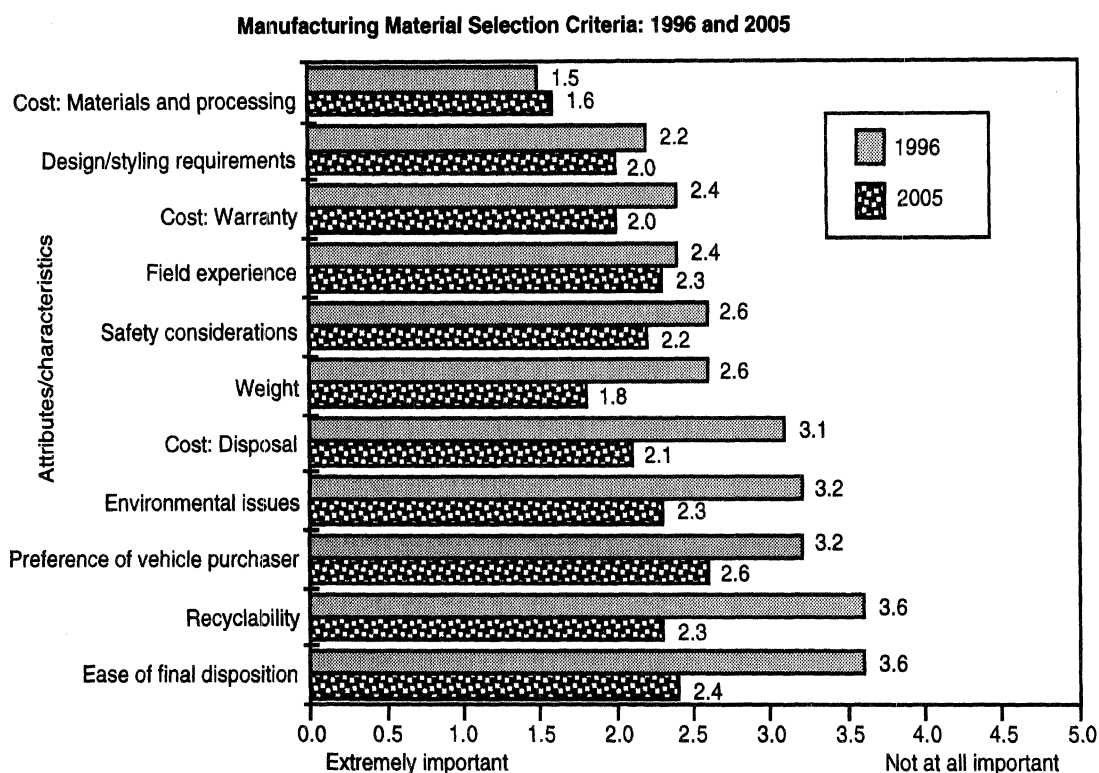
Also critical is the development of a design that enables port access only to non-critical electronic systems. Any system that does not prevent the user from altering critical operating systems such as engine management will not be a viable candidate for application.

Finally, the acceptance of a standard data bus is essential to the success of generic ports. It appears that the industry is moving toward CAN as the standard for multiplexed ports. However, complete acceptance is far from assured. This is another area where the ramifications of the vanishing boundaries between consumer and automotive electronics could be significant.

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INT-30. The automotive manufacturers base their material decisions on many criteria, including a number of attributes and characteristics of competing materials. Please indicate your view of how the manufacturers rate each of these attributes and characteristics in the material selection process. Please give your view for 1996 and 2005.

Where 1 = extremely important, 3 = somewhat important, and 5 = not at all important.



Selected edited comments

- Materials are all today essentially interchangeable commodities - materials specialization only applies for low volume type cars - COST! COST! COST!
- Number 1 is cost.

Discussion

Panelists rate the cost of materials and processing as the most important material selection criteria currently (1.5) and in 2005 (1.6). However, weight, currently rated as the fourth most important criteria (2.6 for 1996 and 1.8 for 2005), is forecast to be nearly as important as cost of materials and processing in the coming decade. With the exception of cost, all of the listed selection criteria are rated as being more important in 2005 than in 1996.

Strategic considerations

Although cost continues to be the most important attribute in the automotive interiors material selection process, there are a variety of often conflicting factors. The two factors rated by the panel as most important in 2005—cost and weight—are an excellent example. The industry has traditionally relied on high weight/low cost materials. However, as pressure to reduce weight increases, the industry is looking more closely at low weight/higher cost materials. By rating

cost and weight as the most important selection criteria, the panel suggests that this cost-weight dilemma will continue for at least the next decade.

Environmental issues (3.2), recyclability (3.6), and ease of final disposition (3.6) are rated as slightly less than somewhat important in 1996. However, the panel expects their importance to increase significantly in the coming decade. It is important to note that the rating for each of the three attributes pertaining to environmental challenges decreases by approximately 1.0 between 1996 and 2005. This suggests that panelists strongly believe there will be an increased pressure to develop and manufacture more environmentally friendly vehicles.

Finally, it should never be forgotten that the consumer must be pleased with materials; do the materials fit with the consumers value equation? In some cases, such as with a seat structure, there may be little customer sensitivity, but in other cases, such as with a seat cover material or dash, that may be an entirely different story.

INT-31. For the following North American-produced passenger car and light truck components, please indicate what percentage is likely to be made from the listed materials currently and by 2005.

Component Material	Median Response		Interquartile Range	
	Curr Est.	2005	Curr Est.	2005
Seat frame				
Aluminum	10%	15%	8/12%	10/18%
High-strength steel (HSS)	10	10	10/16	10/20
Magnesium	0	5	0/2	3/5
Polymer composite	1	5	1/2	4/13
Steel	73	59	60/76	30/64
Seat cover				
Knitted and cut	75%	65%	71/80%	60/70%
Leather	20	24	19/20	20/30
Self-skinned	4	8	0/9	4/14
Seat cushion				
Polyester	0%	4%	0/1%	0/5%
Urethane	98	90	95/100	80/94
Woven/suspension	1	5	0/5	5/10
Carpet fiber				
Nylon	50%	45%	50/59%	34/60%
Polyester	30	28	21/30	19/33
Polypropylene	20	20	20/20	15/30
Instrument panel cross beam				
Aluminum	2%	5%	0/5%	3/10%
Polymer composite	1	6	0/3	3/10
Magnesium	1	6	0/4	3/10
High-strength steel (HSS)	20	15	6/25	10/30
Steel	73	57	61/80	40/66
Carpet backing				
EDPM Rubber	0%	0%	0/0%	0/0%
PET	0	0	-	0/0
Polypropylene	100	100	78/100	40/100

Component Material	Median Response		Interquartile Range	
	Curr Est.	2005	Curr Est.	2005
Instrument panel skin				
Polypropylene	10%	10%	0/35%	10/43%
Polyethylene	0	0	0/8	0/8
PUC	0	0	0/12	0/19
PVC	65	53	40/99	30/79
Instrument panel core				
ABS	0%	0%	0/5%	0/5%
Engineering technoplastics	35	50	0/70	0/75
Urethane	65	40	15/90	8/78
Door trim panels				
ABS	5%	3%	0/28%	0/20%
Polyethylene	0	0	0/16	0/10
Polypropylene	52	73	50/68	51/85
Polyurethane	5	5	0/11	0/16
Wood/fiber	5	0	0/15	0/11
Headliner				
Fabric	0%	0%	0/0%	0/4%
Felt/cardboard	5	3	0/10	0/10
Fiberglass	30	20	25/48	10/20
PET	0	0	0/0	0/5
Polyester	0	5	0/3	0/10
Urethane	50	60	43/60	43/65
Airbag doors				
Urethane	30%	38%	10/65%	10/50%
PVC	20	25	0/62	0/54
PUC	0	0	0/5	0/6

Selected edited comments

- Believe there will be a material revolution in the next 5 years.
- Urethane, PVC, PUC combination, possibly, under airbag doors
- With regard to airbag door, does this refer to cover material or core? These are generally multi-material components - e.g., steel/aluminum or plastic core, PUC skin, polyurethane foam, my answers are for surface/cover.

Discussion

The panel forecasts seat frames, instrument panel cross beams, skins and cores, door trim panels, and headliners to experience material usage changes in the coming decade. Conversely the panelists forecast seat covers, carpet fiber, and carpet backing materials to remain relatively

unchanged. However, the wide interquartile ranges for materials on several components suggest that there is some disagreement or uncertainty regarding future materials for these components.

Strategic considerations

Many factors influence material selection. Materials for each of the listed components must meet stringent requirements in order to be accepted. (Question 22 includes a forecast of critical selection criteria.)

Because of their light weight, magnesium and aluminum have increasingly gained acceptance for use in seat frames and instrument panel cross beams. Yet the cost of these materials may prevent them from gaining significant penetration for these applications in the coming decade.

Many of the listed components will experience battles for increased usage between two or more different types of plastic. These battles will be driven by the need to reduce manufacturing and material costs, but also by the increased likelihood of recycling.

With regard to automotive interior materials, the next several years will likely be a highly volatile time, with much activity. New developments will come from a wide range of industry participants. Companies will need to maintain active intelligence gathering programs.

One point of importance is to consider each application in the context of a broader set of system issues. For example, material selection may be profoundly affected by emerging design and manufacturing technologies. Increasingly, material selection decisions must include, not only the effect of the selected material on the component, but also the materials effect on the system.

INT-32. Please indicate future material processing and component assembly trends for the listed components in the coming decade.

Carpet

Material and application	Process change
Polyurethane foam backing	Molded to the carpet
Polyurethane - backing	Pour in place polyurethane
Polyurethane	Pour in place for improved fit and acoustics
Polyurethane foam backing contoured to fit floor	Pour in place/low pressure molding

Selected edited comments

- Anticipate dual density - different nap heights
- Fire and flame protectants may increase.
- More nylon and recycled nylon
- Nonwoven material will increase
- One step forming of entire process
- Polyurethane used in backing
- Use of more recycled material

Headliner

Material and application	Process change
100% polyester version	Deeper draws in corners
Polyurethane substrate	Continuously produced
Various substrate materials (increase in PET), addition of sound source components	Adding/assembling/supplying complete modules including lighting, electronics, sound, HVAC, etc.
Urethane	1 piece molded including pillars
PET, urethane	More structural and recyclable molded laminates
Move to nonwoven lower cost construction, fabric laminate	Fabric composite
Elimination of fiberglass	Use natural fibers
Foamed thermoplastic alloys styrene and Polyphenylene ether	Thermoforming

Selected edited comments

- 100% polyester version; varying densities across headliner (denser near roof rail)
- More components molded in antennas, for example
- PET recyclable fiber substrate; marriage of headliner and overhead system
- Use of more recycled material

Hard Trim

Material and application	Process change
TPO and PP for A/B/C pillar modules	Co-injection or 2-stage injection enabling 2-shot soft/hard skinned systems
HCPP, new TPEs	Injection molded, no paint
Eliminate unstable dimensionally changing materials - plastics	Fiber materials
Polypropylene	Injection molding

Selected edited comments:

- Better color fastness expected, higher polymer melt temperature
- Expect more foam added for occupant protection
- Incorporation of new engineered thermoplastics with better color fastness, UV resistance, dimensional stability
- Injection molded polypropylene pillars with integral head impact capabilities are anticipated.
- Need a cost effective soft/tough process/material to be invented
- Recyclable material will increase.

Instrument panel/Cockpit module

Material and application	Process change
TPO/PPO instrument panel and door panel trim, etc.	2-layer soft/hard injection and blow molding and/or TPO/PPO lamination
Reduced use of urethane foam, monolithic construction or styrene	Vacuum forming of composite sheet
PUC skins switching to urethanes or TPO; increasing use of PC/ABS (hard instrument panels)	Increasing use of injection molded hard instrument panels
Polycarbonate/ABS alloys and metallocene catalyzed PP	Injection molding

Selected edited comments

- Less steel will be used.
- Recyclable material will increase, both surface and form.
- Snap together forms are anticipated

Seats

Material and application	Process Change
100% polyester version; replace metal springs	Recycling of old seats, scrap material included
Recyclable foam	Less human involvement
PET fiber for cushions	From poured polyurethane foam to fiber-based cushions molding process
Move to nonwoven for cushion (cheaper and recyclable)	Move to prints for fabric

Selected edited comments

- Expect less foam, more webbing
- Expect thinner cross sections, inclusion of more sensors/controls

- HSS frame with STP polyester fabric seats is anticipated
- More foam in place is anticipated

Other

Material and application	Process change
PSIR (airbag) doors	Integrated into structure without any visible lines
Polyester substrate and integration	Tool free attachments methods
PUR/Glass and PET substrates, modular assembly including lighting, sound	Complete module assembly to car
Recyclable material	Compression molded and low pressure molding
Soft/hard 2-shot, TPO/PP	Co-injection and/or 2-layer blow molding
Crystalline polypropylene	Increased use of injection molding
Instrument panel skins TPO and PV vs. PVC, 2-shot TPO/PP for touchable surfaces	TPO and polyurethane powder casting, 2-shot injection for door panels, components
100% polyester version; thinner cross sections	Built for easier disassembly
PET fiber replacing foam polyurethane	New fiber based process

Selected edited comments

- Use of injection molded structural tray with sound deadener; integration with seat back
- Use of more recycled materials to lower cost and permit reuse of materials, and more use of dual modeling/exterior techniques of premium materials; also, "show of surface" of recycled materials may be used as backing

Discussion

The panelists list a wide variety of manufacturing advances that are likely in the coming decade. The advances include both material and process innovations.

Strategic considerations

The automotive industry faces increasing pressure to develop lightweight, cost-effective materials. The panel lists a wide variety of activity, some of which will likely have significant potential, while others may fail for any number of reasons. The breadth of the responses indicates a significant level of activity. We strongly suggest that the potentially impacted reader review the listed material processing and assembly trends closely.

INT-33. Do you expect federal or state government legislation and regulations to require the recyclability of automotive materials in the following areas? Please give your forecast for 2000 and 2005.

Where 1 = extremely probable, 3 = somewhat probable, and 5 = not at all probable.

Regulatory Issues	Mean Rating	
	2000	2005
Specific regulation for the following:		
Disposal of used tires	2.2	1.4
Disposal of automotive fluids	2.5	1.6
Recyclability of plastics	2.8	2.1
Establishment of uniform identification/coding standards for materials to facilitate separation	2.8	2.1
Ban on some current automotive materials	3.4	2.5
Required minimum recycled content	3.6	2.8
"Take back" regulations making manufacturers responsible for final product disposition	3.6	2.9
Financial penalties/incentives based on recycled content	3.7	3.1

Selected edited comments

- Recyclability and the broader issue of environmental quality is a major consumer trend.
- Recycling is a disappointing issue—new focus on total car vs. individual components - cost of disassembly and cost of design for disassembly too high for high volume recycling.
- The Europeans will be much further along concerning recycling as compared to United States and Canada.
- Waste to energy will become a recycle option for a limited percentage of the plastic in the vehicle.

Discussion

The panel forecasts as probable federal regulation/legislation regarding the disposal of tires (1.4), the disposal of automotive fluids (1.6), recyclability of plastics (2.1), and uniform coding standards for materials (2.1) by 2005. In the short term, all of the listed actions are viewed as only somewhat likely.

Strategic considerations

The industry faces increased pressure to make more environmentally friendly vehicles. This pressure is driven by at least three forces. First, the amount of plastics is increasing in automobiles. Second, European regulation is setting a standard that may be matched in other regions. And third, customer awareness of environmental issues is increasing.

Although plastics have long been used for interior applications, they are seeing increased usage throughout the vehicle. This added plastic volume has led to an increased amount of

automotive shredder residue (ASR) going to landfills. This, in turn, has created an increased awareness and concern among environmentalists.

The German government, for several years, has been the leader in the regulation of automotive recycling. Germany has enacted a number of laws pertaining to the final disposition of the automobile, including the "take back" law requiring manufacturers to be responsible for the final disposition of their vehicles. The precedent set by these laws will likely have some effect on the North American market.

Consumers are increasingly aware of environmental issues, and their purchases are beginning to reflect this awareness. Although it is unlikely that new car shoppers will soon make recyclability a major purchase criterion, they will become increasingly interested in the environmental impact of the vehicles they drive. Companies should proactively position themselves as environmentally conscientious.

INT-34. Relative to plastics usage in the next decade, how likely are the auto manufacturers to undertake each of the following actions in the coming decade?

Where 1 = extremely probable, 3 = somewhat probable, and 5 = not at all probable.

Action	Mean Rating
Pass-through recycling requirements to suppliers	2.0
Restrict the amount of economically unrecyclable plastics in the vehicle	2.5
Restrict the number of types of plastics in the vehicle	2.5
Better design for metallic components	2.7
Substitute lightweight metals for plastics	3.2
Restrict the amount of plastics in the vehicle	3.5

Selected edited comments

- Historically, automobiles are leaders in recycling among consumer products—use of diverse kinds of materials (plastics, exotic metals) only makes recycling that much more difficult. Further standardization of kinds of materials to aid recycling will be the order of the day. Steel will remain “king.”
- Metals are not necessarily more economically recyclable than plastics.

Discussion

Panelists forecast as probable that manufacturers will pass through recycling requirements to their suppliers (2.0). All other listed actions are seen as only somewhat probable.

Strategic considerations

Plastic is the material of choice for many interior applications, and it will remain so for the coming decade. However, the final disposition of plastics continues to present a challenge to the industry. All interested parties are diligently working to develop acceptable strategies. Several companies are developing requirements limiting the number of families of plastics per vehicle. The ability to have complete subassemblies made from the same family of plastics may allow for easier reclamation and recycling. With regard to many interior applications, material selection may not be between plastics and other competing materials; but will instead be between different families of plastic.

There continues to be a great deal of discussion about who is responsible for the recyclability of vehicles. Some suggest that, because their name is on the product, the manufacturers must assume final responsibility. Others believe that the material supplier should take the lead in recycling. Although it is true that the manufacturers will be held accountable, we also see significant marketing potential for proactive suppliers. The ability of a supplier to deliver a highly recyclable interior system that meets all standards may place the supplier in a stronger competitive position.

INT-35. What percentage of North American-produced passenger cars and light trucks will use materials other than conventional glass for windshields, side windows, or rear windows in 2000 and 2005?

Alternative Material for Glass	Median Response					
	2000			2005		
	Windshield	Side Window	Rear Window	Windshield	Side Window	Rear Window
Polycarbonate	0%	0%	0%	0%	4%	4%
Polycarbonate-glass laminates	0	5	5	0	7	10
Special coatings and/or interlayers to:						
Reduce solar load	20%	10%	10%	30%	20%	20%
Provide defrosting capability	10	2	10	20	5	20
Provide abrasion resistance for plastics (e.g., diamond film glazes)	0	1	0	0	5	5

Alternative Material for Glass	Interquartile Range					
	2000			2005		
	Windshield	Side Window	Rear Window	Windshield	Side Window	Rear Window
Polycarbonate	0/0%	0/2%	0/2%	0/0%	0/5%	0/5%
Polycarbonate-glass laminates	0/0	2/5	0/5	0/5	5/10	5/12
Special coatings and/or interlayers to:						
Reduce solar load	10/20%	8/20%	8/10%	25/40%	10/39%	16/34%
Provide defrosting capability	5/16	0/5	5/15	9/30	0/10	10/30
Provide abrasion resistance for plastics (e.g., diamond film glazes)	0/1	0/5	0/5	0/3	3/9	0/6

Selected edited comments

- There will be introduction of conventional laminated glass on side windows for reducing occupant ejection and/or security reasons beginning approximately 2000.
- With a conscious effort to reduce sunload and heat transfers through glass (cost effectively), it would garner quite a ripple effect in cost gains - less expensive instrument panel skins - less load on A/C - smaller air conditioner - light weight, less horsepower and gasoline required.

Discussion

The panel forecasts minimal penetration of polycarbonates for windshield, side window or rear window applications by 2005. However, the panelists do forecast some growth in special coatings/interlayers to reduce solar load and provide defrosting capability in the coming decade.

Strategic considerations

Current styling themes continue to promote large glass surfaces. As more glass is used, it becomes an increasingly attractive site for replacement by lightweight alternatives such as polycarbonates.

Glass will continue to be the material of choice for all listed applications. It is expected that polycarbonates will initially be used for side and rear window applications. However, it is likely that these applications will only occur in situations where weight reduction is vital. Use of polycarbonate for windshield applications present a significant weight reduction opportunity. Yet, polycarbonates have lower resistance to scratching, less sound dampening, and offer less forgiveness at impact than glass laminates.

The increased greenhouse effect presented by current styling themes will also likely lead to increased usage of coatings and interlayers to reduce solar load on the interior. The use of coatings and interlayers that reduce ultraviolet rays and temperatures within the interior may allow the relaxation of some durability and fade requirements for interior materials.

There is creative work being done that could lead to new window material strategies and therefore alter the forecast significantly.

INT-36. Please indicate how materials will influence the improvement of future customer satisfaction for each of the listed areas over the next 10 years.

INTERIOR

QUALITY/RELIABILITY/DURABILITY:

- Anticipate TPOs and TPEs for IP and DP skins for durability and invisible PSIR doors
- Continued strides in better fit/finish and durability will require new materials at lower cost
- Expect fewer irritant failures or minor breakage and stronger electronics
- Improved resistance to scratching, scuffing, and abrasion without paint
- Less fading, light weight, stronger materials with improved scratch resistance and low and high temp resistance
- Less fading, more weather (sun light) resistant material will extend the serviceability
- Through better and more uniform functional characteristics
- Quality and customer satisfaction are positively correlated.

FIT and FINISH:

- Continued strides in better fit/finish and durability will require new materials at lower cost.
- Expect improved dimensional stability over wide temperature range
- Foresee materials with minimal temperature sensitivity for invisible PSIR
- Foresee more stable materials, such as fiber
- Less expansion, less fading, better color matching, etc. are anticipated
- Modular designs will maintain original dimensions
- No squeaks and rattles implies good quality and improved customer satisfaction
- Squeak and rattle/noise reduction, quiet cabin the norm in small as well as luxury cars
- Uniformity in touch and appearance is expected

ERGONOMICS:

- Anticipate seats that tip for egress
- Cockpit designs give feel of total control/easy reach
- Easy to use and understand controls and features are positively correlated to customer satisfaction.
- Ergonomics more related to design and positioning than materials.
- Expect higher friction materials for steering wheel, switches for better grip; also, lower friction for seat covers for better entry/egress and redistribution of pressure
- Module design will improve the assembly related issue.
- More sound absorbent materials, better feel/handling
- Soft touch materials will increase.

SAFETY:

- Collision avoidance is the real key to the feel of security.
- Low gloss, low scuff, less brittle coatings will reduce glass shattering.
- Materials will enhance security.
- Materials will support head impact requirements.
- More shock absorbent materials are expected
- Nonsplintering materials (on impact)

- This is the area of most change. Lighter weight, environmentally neutral, energy management materials will be utilized throughout the interior.

OTHER (PLEASE SPECIFY):

- Styling: I'm afraid we're in for some sort of unfortunate "styling explosion" (see Ford "edge look") which will drive search for new materials applications.

Discussion

The panelists' responses include four basic types of customer improvement associated with material advances in the coming decade. The panel expects quality/reliability/durability, fit and finish, ergonomics, and safety to all see significant improvement due to better materials and processes.

Strategic considerations

Material developments for interior applications will lead to better quality/reliability/durability, fit and finish, ergonomics, and safety. Hopefully, it will also lead to lower costs in the coming decade. These gains will come from increased knowledge of manufacturing methods and continued material development. The selection of many interior materials presents a unique challenge. Obviously, the material must meet the performance requirements with respect to safety and durability. However, it must do so while meeting appearance and feel standards that are associated with components in direct interface with people and, of course, it must also be affordable.

INT-37. What materials issues will present the most significant challenges or opportunities to the North American automotive interiors industry in the coming decade? Please consider all aspects of the business, from concept design to manufacturing, use, and disposal.

Challenges:

- Better quality, low cost, better durability, disposal
- Commonization of plastics reducing design flexibility, cost of plastics increasing faster than inflation, difficulty of recycling composite plastics, long term structural tolerance of plastics is an issue, because of property degradation
- Cost increases by materials suppliers, fewer polymer types to assist recycling, greater durability at less cost
- Cost, quality, supply base rationalization
- Disposal - recycling, safety
- Disposal, cost
- Magnesium's cost reduction, engineering plastics strength, durability, polycarbonates substitution for glass
- Meeting consumer demands while satisfying potential government regulations, cost targets, and higher performance requirements
- PET headliner substrate-cost and weight, urethane headliner substrate-acoustics/recyclability, alternatives to PVC at lower cost, recyclability
- Plastics recyclability, cost pressures may reduce quality (fit/finish and durability), disposal of explosive airbag material/recycling this material, "seamless" integral integration of new "mega" suppliers
- Recycling
- Recycling, durability, more design responsibility
- Recyclability and monitoring, reduced lead times
- Resource consumption, recyclability
- Supply sources and quantities
- System recyclability, color coordination between different plastic types, best use of space, cost reduction without sacrificing performance or quality
- The industry will totally globalize - delivering specific configuration at numerous world locations.

Opportunities:

- Additional energy absorption legislation, lighter weight for electric vehicles
- Aluminum for structural applications
- Cost
- Design flexibility, commonality
- Disposal - recycling, safety, seat design - comfort/vibration reduction, NVH
- EV or hybrid vehicles must be very light, ability to vary mold color body panels, thermoplastic (recyclable) structural composites
- Globalization of entire industry
- Globalization, weight/emissions, recycling, integration of non-traditional sub system components
- Lower cost headliner cloth and substrate materials, airbag cover materials at lower cost, improved durability

- Meet new styling trends, contributions to safety (head impact/belt systems/safe airbag propellants), reduced cost materials
- New environmentally friendly; material as exteriors are more similar, vehicles will differentiate by interiors.
- New hybrid materials, disposal, recycling
- Scrap reduction, smaller compact components, less expensive materials, improved energy absorption/weight
- System design and supply improvements, expansion of design capabilities

Discussion

Although the panelists present a long list of challenges, cost reduction and recycling are by far the most common responses.

Strategic considerations

Again, as with all of the open-ended questions, the breadth of responses is significant. The automobile industry faces substantial challenges and many of those challenges directly affect the interior sector. The panelists list many challenges and opportunities that may be of critical importance to participants in the industry.

The most frequently mentioned challenge is recycling. The industry is becoming increasingly aware of the difficulty in recycling automotive plastics. Technically, all plastics are recyclable, but the development of a cost effective plastics recovery/recycling infrastructure appears to be a difficult long-term challenge. Nowhere is that challenge more apparent than the selection of materials for interior application. Automotive interior plastics represent a large portion of automotive shredder residue (ASR).

The industry continues to attempt to balance the desire to reduce vehicle weight through the use of higher-cost lightweight materials and the need to maintain affordability. Total vehicle weight has been increasing in recent years with much of this weight due to increased safety and convenience options. Manufacturers and suppliers have, to some extent, offset this added weight by increasingly using lighter materials, in turn offsetting the cost of these lighter materials by developing more cost-effective manufacturing processes. However, future weight reduction will be increasingly costly unless there is significant innovation. Utilization of true systems engineering holds considerable promise for increasing value at lower cost.

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INT-38. Several North American vehicle manufacturers are moving to a global platform strategy. What styling/design, manufacturing, program management and product feature challenges does such a strategy present to interior suppliers? *[Underlined headings represent OSAT groupings of common ideas.]*

Styling/design

Local styles/markets (8 comments)

- Adapting to the different range of physical sizes of occupants, icons vs. labels
- Adapting to local tastes, regulatory complexity
- Interior suppliers need to recognize cultural differences between markets.
- Must consider local tastes
- One style to fit all is very difficult.
- Regional markets will always desire different style and design.
- Responding to market tastes and requests
- Responding to regional styling preferences

Localized offices/designers (3 comments)

- Establishing localized office
- Lifestyles vary across the globe and not every stylist thinks in both LH and RH drive.
- Need for talent and studios in multiple locations

Design flexibility (4 comments)

- Determining how to create effective design for multiple markets (geographic)
- Permitting flexible design approach to adapt to changes for local content
- Providing a fundamentally sound generic design structure/core which has the capabilities to be modified quickly and economically to meet local regulations and cultural needs

Other

- Styling tastes, driving (and parking) environments, customers packaging requirements, and regional regulations and taxes all conspire against "global platforms," e.g., Ford's Contour/Mystique is out of sync with US tastes, being too small and too expensive.

Manufacturing

- Bearing investment cost without long term commitment from OEMs
- Capitalization, especially in emerging markets; supply of necessary components
- English vs. metric dimensions, fasteners, components
- Establishing local manufacturing supply sites
- Establishing local supply
- Harmonizing manufacturing processes is extremely difficult as unique techniques have evolved in developed countries, and many enhanced techniques cannot be used in developing nations, making common designs difficult.
- Labor/government restrictions - local conscience in countries without restrictions
- Localization (one design, production at several locations)
- Matching the technical capabilities and work skills of advanced versus emerging markets
- May require refined manufacturing for costs

- Process for volume of build, skills for assembly
- Regional differences in cost and competency
- Transfer of best practices world wide

Program management

Skilled managers (4 comments)

- Developing the work skills, management skills, and product understanding to work across all cultures and language sectors
- Higher leadership skills required, as well as diversity expertise and foreign language skills
- Must have a lot of authority.
- Need program managers with international experience, and more importantly, tolerance for different cultures.

Transfer of knowledge (3 comments)

- Establishment of global support of vehicle manufacturer via system supplier center of excellence
- Requirement of many trips/communication by telephone or video conference between 3 continents
- Transferring lessons learned around the globe

Other

- Finding adequate talent; expense
- Increasing amounts of "remote control" is caused by globalization
- Language barrier, cultural understanding
- Language barrier

Product features

- Complexity
- Despite OEM wishes, product differentiation across countries will be a challenge.
- Flexibility to add/delete features must be consistent with various levels of economies as well as product usage.
- Interior suppliers need to recognize cultural differences between markets.
- Must force expanded flexibility
- Must learn how to make the most important features perfect instead of having multi cultural components
- Need for both left hand/right hand drive, extent of luxury features
- Need to consider local market preferences
- Packaging of basic functional features

Discussion

Panelists present a wide variety of challenges for the listed functions/activities with regard to implementation of a global strategy. The ability of a company to adapt to local markets and tastes, local versus centralized control, design flexibility, and limited capital resources are the most common themes presented.

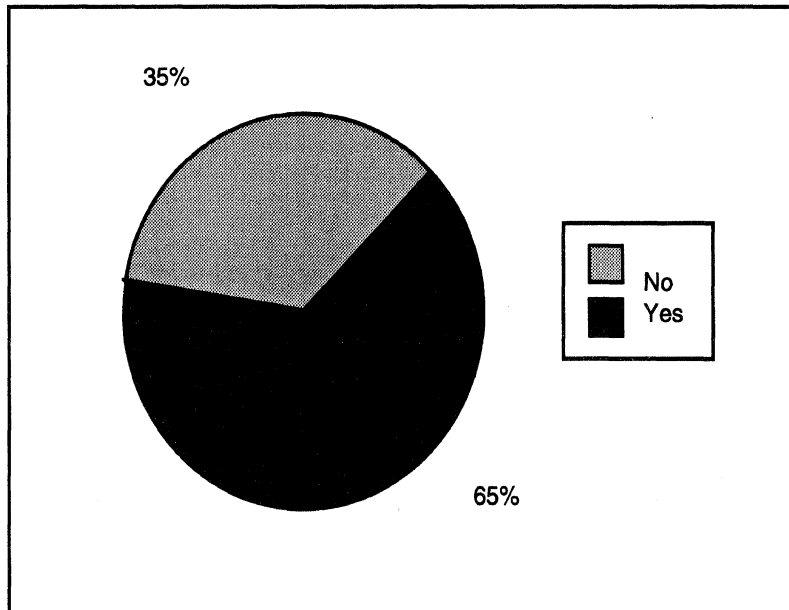
Strategic considerations

Suppliers of automotive interior systems and components face many challenges with regard to globalization. All automotive suppliers face operational, capital, and cultural barriers, yet interior suppliers also face the challenge of styling and design to meet the needs of unique local tastes. The interior of the vehicle is an essential interface between the occupants and the vehicle. Global strategies will lead to standardization between regions of many components that are transparent to the customer. However, the effort to reduce cost will also likely lead to global standardization among some components that directly interface with the consumer, even where cultural differences may suggest unique componentry. The ability to compete in global scale economies while at the same time satisfying local tastes will present an important challenge for interior suppliers. Those that satisfy local tastes and are able to strike the best balance will be strongly positioned in the coming decade.

All industry participants must carefully plan capitalization strategies. Many suppliers are asked to follow their customers into new regions. Suppliers will likely face difficulties in capitalizing this expansion and must plan carefully to prevent becoming overburdened financially. Some companies will likely respond to their customers' requests to expand globally by entering strategic alliances with suppliers from other regions.

Clearly the growing demands of globalization are one the major forces prompting the significant mergers and acquisitions actively underway on a worldwide basis.

INT-39. Will globalization affect interior system suppliers differently than interior parts suppliers?



Selected edited comments

- As the program/project managers, system suppliers will need increasing amounts of "managerial agility" to stay on top.
- Integrators need multiple sourcing, leading to somewhat different development, respectively.
- May need to supply to many different countries in assembly friendly packages different for each assembly plant, currency management, launch support.
- More will be expected of interior systems suppliers, e.g., pressure from OEMs to "follow them around the globe" with resources.
- System suppliers will be global, parts suppliers will be localized. Therefore, the global systems suppliers will be integrating the same parts built by different suppliers.
- Systems suppliers will face higher investment for multi-processes while parts suppliers have to facilitate only a single process capability.
- Systems suppliers will have difficulty dealing with the complexity of the issue.
- Systems suppliers will need to address all variables of globalization including those detailed in previous questions. The systems suppliers must be visible globally and participate in many local arenas. Parts suppliers will hang on to their coat tails for guidance and cost avoidance.

Discussion

A majority of the respondents (65 percent) expect globalization will affect systems suppliers differently than part and component suppliers. According to those that see a difference, systems integrators and suppliers will be required to have global capabilities, while part and component suppliers will be more likely to have regional requirements.

Strategic considerations

System integrators and suppliers will likely be required to develop a global presence. Conversely, many component suppliers will maintain a regional focus. System integrators will be responsible for buying identical parts or components from regional suppliers. Therefore, it becomes imperative for system integrators to become skilled at managing complex systems.

This regional sourcing will probably lead to the development of a regional subsystems infrastructure with a concomitant increase in complexity.

This strategy also raises concerns for component suppliers. Chief among those concerns is engineering proprietary rights. Suppliers are being asked to take more responsibility for product engineering. There is presently concern among suppliers that this increased effort is not being properly valued by the manufacturers. The potential for manufacturers (or system integrators) to require increased engineering effort only to shop the plans on an international marketplace is disconcerting to all suppliers. It may become increasingly worrisome as the industry moves toward a global strategy.

INT-40. There is significant interest in emerging markets (i.e. Southeast Asia, South America, etc.). What unique styling/design, manufacturing, program management and product challenges do emerging markets present to the automotive interiors industry?

Styling/design

- Adapting to different customer tastes
- Adapting to varying demands in terms of vehicle size and complexity, e.g., Asia-simple cars vs. South America-complex
- Designing specific to market
- Learning consumers preferences and designing vehicles to meet their budgets
- Lifestyles are different, therefore interiors need to take this into consideration - North America may be the only market where cup holders are necessary.
- More emphasis on function rather than style
- Must begin with single basic designs
- Need to comprehend differences in anthropometry across countries
- Regional tastes
- Requires culture correctness otherwise markets are growing together.
- Responding to local tastes
- Styling tastes, driving (and parking) environments, customers' packaging requirements, and regional regulations and taxes all conspire against "global platforms", e.g., Ford's Contour/Mystique is out of sync with U.S. tastes, too small, too expensive.
- Understanding product usage and/or conflict with cultural expectations (i.e., is leather acceptable in India?)

Manufacturing

- Adapting to local laws, tariffs, local conscience where there are no regulations
- Advantage of lowest cost
- Capital investment without the predictable volume to support it; supply of critical components
- Establishing local plants
- Harmonizing manufacturing processes is extremely difficult as unique techniques have evolved in developed countries, and many enhanced techniques cannot be used in developing nations - making common designs difficult.
- Low cost advantages
- Obtaining local manufacturing consent
- OEM should source more product to fewer suppliers.
- Reliance on human labor vs. automation
- Training, operation, floor supervision, quality
- Unions, government regulations, safety, labor training, work ethics, negotiating skills, communications, language are all important challenges associated with emerging markets.

Program management

- Availability of experienced talent
- Complexity of workforce
- Extensive travel
- Local center of excellence can be developed to provide global program management.
- Necessity of being quick to market, given short lead times

- The increasing amounts of “remote control” caused by globalization
- Utilization of video conferencing and remote engineering design for emerging markets
- We are not yet multiculturally world class in N.A.

Product features

- Careful with the bells and whistles and system layout for consumers, i.e. right hand drive in Japan (Ford)!!!
- Different/fewer product features than on comparable NA or European designs; pressure for lower cost
- Economic buying power, safety expectations, life styles, (i.e., cup holders)
- Good gas mileage, reliability
- Learning consumers preferences and designing vehicles to meet their budgets
- Low cost advantages
- Providing value that appears more expensive than it actually is
- Responding to local tastes
- Staying with basics or most competitive features to encourage maximum volume affordability

Discussion

Panelists most frequently list the ability to understand the customer as a unique challenge to entering emerging markets from a styling and product feature perspective. With respect to manufacturing, the panelists view the challenge of balancing capital resources as critical to entrance into emerging markets.

Strategic considerations

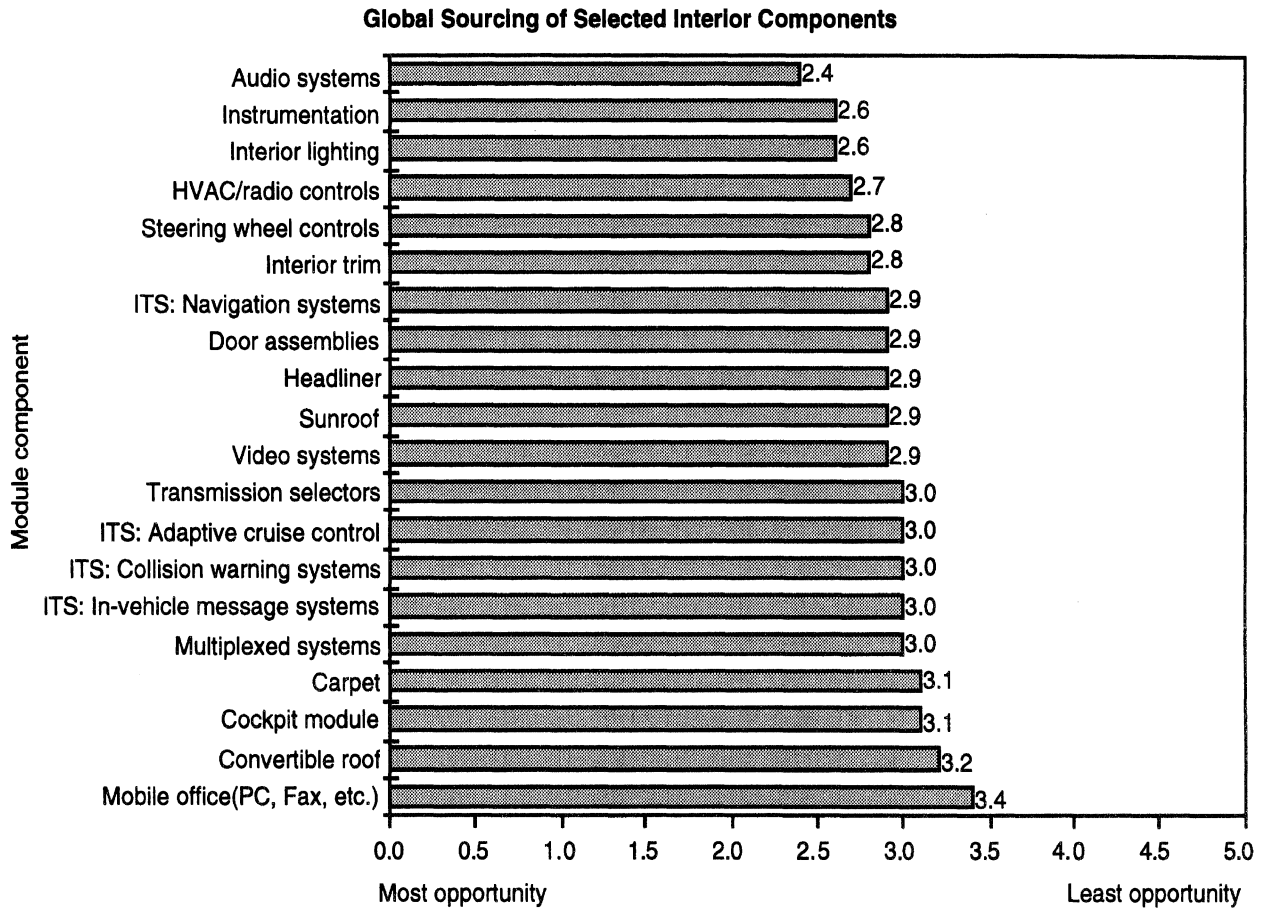
During the past decade, North American manufacturers have spent and are spending considerable effort and money to enter emerging markets. These new markets are often markedly different than the U.S. market, and a proven record of success in North America does not guarantee success in Southeast Asia or South America. Suppliers that follow their customers to emerging markets will need all the skills that made them successful in North America and an increased level of flexibility and adaptability to the special circumstances they will face in each region.

Many emerging markets have ample labor for production, but very limited technical and managerial labor pools. The ability of companies to develop a competent local team may be an important advantage to localized production, and therefore a key element of a successful emerging market strategy.

Emerging markets may at least initially be comprised of two very separate markets. Inevitably there will be a low-volume upscale vehicle market, but there will also be a much higher-volume, low-cost subcompact segment. North American producers will likely experience success in meeting the needs of the developing larger vehicle markets. The challenge for these manufacturers may be the development of a low price small vehicle. Manufacturing strategies and vehicle designs that present low-cost options while still maintaining vehicle quality will be key to success in emerging markets. Strategies such as the recently opened Volkswagen assembly plant in Brazil, and Chrysler’s plastic panel, emerging-market concept car should be closely monitored.

INT-41. Please indicate the likeliness of the following components to be sourced on a global basis.

Where 1 = most opportunity, 3 = moderate opportunity, and 5 = least opportunity.



Selected edited comments

- I can't think of anything that won't be globally sourced.
- Many interior systems are specific to local market customer demand or regulation. This will slow globalization for many components. For many other generic components, there are few barriers to globalization except the capability of the supply base.
- Purchasers of the above will seek low cost.
- Pure entertainment electronics (Korea/Taiwan), complex electrical United States/Western Europe, full modules - close to highest volume assembly plant.
- Where there is a high value of engineering content, global sourcing will be required to develop cost effective products.

Discussion

All listed components are rated as at least moderately likely to be globally sourced. However, panelists rate audio systems (2.4), instrumentation (2.6), interior lighting (2.6), and HVAC/radio controls (2.7) as the components most likely to be globally sourced.

Strategic considerations

All of the listed components are candidates for global sourcing. The desire to seek lower cost will continue to drive decisions in the coming decade, and a major element in this cost reduction is the ability to source components on a global basis. However, many interior components and designs are unique to regional markets. The homologization of the automotive interior will likely face barriers from these regional market tastes. Companies will attempt to maintain a balance between the need to gain cost reduction through standardization and the need to satisfy regional customer preferences. Unique solutions like the ambidextrous instrument panel in the Jeep Wrangler should be closely watched. Many successful solutions to the challenges presented by globalization will likely be outside the traditional automotive envelope.

Many ITS technologies will see initial penetration in Japan and Europe. These may give suppliers in these regions an opportunity to establish a leadership position. Companies will need to maintain an active information-gathering function that includes all key regions of the world.

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DEFINITIONS

LIGHT TRUCK Includes sport utilities, vans and pick-up vehicles.

NORTH AMERICAN-PRODUCED PASSENGER CARS AND LIGHT TRUCKS Refers to all vehicles produced in the United States and Canada.

SYSTEMS SUPPLIER Responsible for program management of systems such as seats, instrument panels and headliners.

SYSTEM INTEGRATOR Responsible for integration of several systems into larger systems, e.g., interior system integrator.

COMPACT Vehicles with retail prices less than \$15,000*.

MIDSIZED Vehicles with retail prices greater than \$15,000 and less than \$25,000*.

LUXURY Vehicles with retail prices greater than \$25,000*.

(*) Constant 1996 dollars without adjusting for inflation.

Note: "year" refers to model year unless otherwise specified.

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