3 Vehicle Concept Considerations

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3.1 BACKGROUND

Various possibilities to achieve the ULSAB-AVC targets were considered for the concept development prior to packaging definition.

Based on the targets set for safety / crashworthiness, mass, structural performance, dimensions and the component material definition, the main influencing factors in the package for a successful program were:

- Platform Approach for both C-Class and PNGV-Class
- Safety Targets for Crashworthiness
- Steel Intensive Vehicle at Low Mass
- Vehicle Dimensions
- Modular Design/Assembly Approach

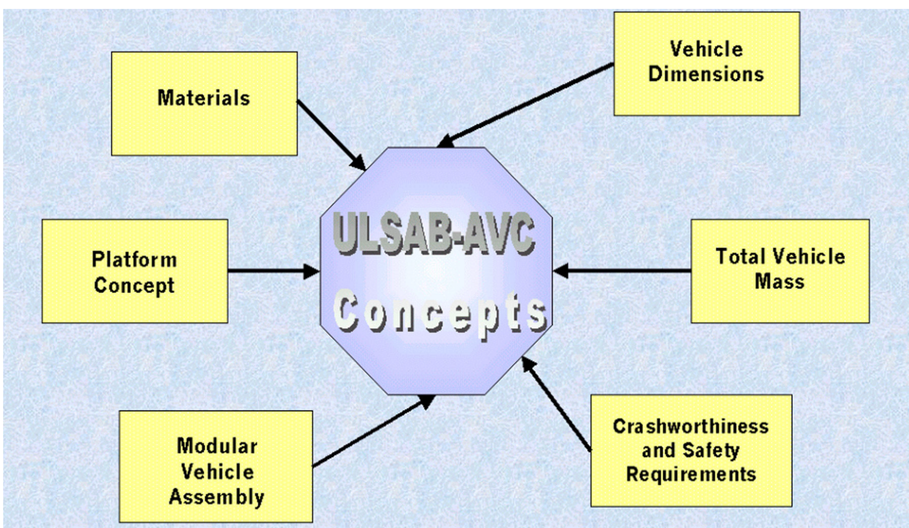

Figure 3.1-1 Concept considerations

The vehicle concept considerations for these and related factors are described in this section.

3.2. Platform Approach

The first decision was to consider a platform approach for both a C-Class and a PNGV-Class concept. The platform variations were defined as front wheel drive vehicles with powertrains and suspensions to accommodate both diesel and gasoline engines.

The main drivers for the concept development were the attainment of future crash and safety requirements coupled with demonstration of low CO_2 emissions and affordability of steel intensive vehicles in 2004 and beyond. Therefore, attention was given to achieving low mass for the total vehicle with particular need to design the body structure for optimal structural performance at low mass. To achieve the desired holistic result, it was important that the engine/powertrain also complement these targets.

The ULSAB-AVC engine concept and front-end architecture are purpose-built to get optimized balance of fuel efficiency and safety while optimizing modular design for assembly approach and servicing.

To achieve safety requirements in the unique front-end package, the engine was positioned behind the gearbox, allowing the powertrain to move rearward into the tunnel during a crash event without intruding into the passenger compartment.

To meet program objectives, an architecture and structural platform were established for C-Class that could be expanded to the size of a PNGV-Class vehicle. PNGV (Partnership for a New Generation of Vehicles) is a U.S. program focused on the size range of the North American Midsize-Class vehicles.

For the body structure concept therefore, it was decided to develop a common front-end structure/package, for both designs to share as many components as possible. The main difference between C-Class and PNGV-Class vehicle concepts is mainly related to the hatchback design of the C-Class versus the four-door sedan design of the PNGV-Class vehicle, also in respect to vehicle size (PNGV-Class + 550-650 mm length).

3.3. Safety

ULSAB-AVC anticipates safety requirements for crashworthiness as defined in Chapter 2 - Program Targets of this report. Consequently, the overall body structure architecture and package were designed to meet the stringent safety targets, which were set and to provide the potential for high vehicle star ratings.

The side pole crashworthiness target made it necessary to consider a different approach to the interior design. Therefore, the front fixed-seat design was chosen to enhance crashworthiness.

In addition, safety considerations with respect to pedestrian head injury protection led to an early decision to design the front suspension with no front shock tower (damper) in order to eliminate hard points (such as the top of a shock tower) immediately under the hood and fenders. This influenced the common front suspension concept design, which then was tuned to account for the difference in total vehicle mass of the two vehicle concepts and for both engine types (diesel and gasoline).

3.4. Axle Load Balance / Handling Performance

The lightweight front-end body concept in combination with an optimized engine bay package was a major factor contributing to a reduction of the front axle load. An ULSAB-AVC design consideration was to develop a more even distribution of total vehicle mass between front and rear axles (due to the front wheels being further forward and the engine/gearbox mass located further back). This results in improved handling characteristics of a lightweight vehicle.

3.5. Vehicle Size / Dimensions / Aerodynamics

ULSAB-AVC's vehicle dimensions were not downsized to meet ULSAB-AVC's aggressive mass targets. Rather, in the interest of creating a design that meets with consumer acceptance in terms of size, comfort, and safety, state of the art C-Class and PNGV-Class interior space and luggage volume capacity, as well as exterior dimensions were maintained.

All package issues, such as angle of approach, defined bumper heights, head position contour and passenger position, were considered. Also, body sections and head position for rear occupants are included. A-Pillar and B-Pillar sections, vision lines, position of steering wheel and column, and tire envelope were defined in order to place the front rail position.

To reduce CO_2 emissions, measures to reduce the aerodynamic drag on the exterior and the drag of the airflow through the vehicle were taken into consideration. This consideration lead to selection of rear-view cameras and flat screen display technology (eliminate mirrors to reduce drag) and enclosed underbelly (optimized airflow, reduced drag).

3.6. Interior Design

Interior design and overall packaging were driven by occupant safety and comfort considerations. As described in Section 3.3, the side pole crashworthiness target and minimum mass targets led to the selection of fixed front seats – attached to a cross-car beam. Adjustable pedals and steering wheel accommodate the fixed seat approach. Packaging dimensions are set to provide maximum comfort dimensions within the defined exterior sizes consistent with C-Class and PNGV-Class. Moving the wheelbase out also helps optimize interior passenger space.

3.7. Assembly and Servicing

For the assembly and servicing of the vehicle, modules integrating several components and functions were considered (e.g. front fascia with bumper beam and air duct). This approach reduces assembly cost and, therefore, overall vehicle cost. It also paves the way for simultaneous engineering with suppliers at an early development stage, thus shortening development time.

The engine bay package layout is an example of this system approach. It features a service module in which the engine/gearbox, front suspension, radiator and steering rack are positioned on the sub-frame and mounted to the body structure. The complete sub-system can be assembled (or disassembled) as one unit from underneath the vehicle.

3.8. Closures

The closure design utilized the findings from the UltraLight Steel Auto Closures (ULSAC) Program – both concept study and validation phase. The objective was to integrate the frameless ULSAC door design concept and the other ULSAC closure concepts into this program.

3.9. Materials and Processes

Use of steel materials and manufacturing processes that reflect state of the art or future trends were primary design considerations. The body structure design analysis was run with high strain rate properties of advanced high strength steels. Fabrication and assembly processes (such as tailored blanks, hydroformed tubes, and laser assembly welding) were also basic considerations for these vehicle concepts.