ABSTRACT

Passenger car manufacturers often outsource the design and development of functionally critical components. Headlamp is one of such units posing challenges to the designer owing to the functional requirements on visibility and styling preferences of customers. A supplier may not have powerful product data management (PDM)/product lifecycle management (PLM) systems as in the case of OEMs. Instead, the use of domain specific computer aided design (CAD)/computer aided manufacturing (CAM) software is expected with the suppliers. The suppliers of headlamps are to be supported with adequate information on changes in style of the vehicle in such a way that supplier can participate in the product development process.

This work is motivated by such a background and tries to provide a solution that can be used as a basic framework for the development of headlamps. A systematic design methodology incorporating high level aesthetics and regulatory requirements was proposed in the first part of this work. The methodology enables the designer to address customer requirements using coherent computer aided design (CAD) platforms. Development of the critical components in headlamp assembly namely, lens and reflector are focussed. The present trend of passenger car styling is the use of headlamp with totally integrated exteriors with the car body. The design methodology provides automatic generation of exterior surface matching with the profiles of car body. The design module for reflector helps generate tailored reflector in compliance with the standard illumination of roads.

The second part of this work is development of product model supporting co-designers and users of the downstream phases of product
development. The multiple views developed in this work are in parameter perspectives. Product development groups involved create knowledge on selected attributes of the product from several functional perspectives. This process is highly iterative and the information models used for product development have to provide consistent and manageable solutions. That is, the knowledge available from upstream function is transferred to the downstream teams for further processing. This leads to the concept of view as practised in industry and hence the relevance of multiple view information models.

The multiple view product model proposed in this work has horizontal and vertical dimensions creating information for co-designers and downstream phases of product development respectively. The horizontal product models manage the relationships among the components. The vertical product models create views supporting assembly and manufacturing. This research has emphasised on manufacturing phase as it poses several challenges to the implementation of changes in the shapes of products.

The third part of this work deals with the selection of manufacturing process and planning of tooling required for manufacturing using the information from the early stages of design. The parts are classified based on the type of surface features included in the part. Surfaces are classified as ideal and non-ideal types. Ideal class represents a component with a feature, which obeys law of physics (like law of reflection of light). Non-ideal class represents a component with feature, which contributes to the aesthetics (like curvature continuity). Product lines are formulated for ideal and non-ideal types of parts. Manufacturing of reflector uses injection-moulding process and information for tooling is derived from the conceptual design. For the manufacturing of lens, reconfigurable manufacturing system is proposed. It includes a software module for converting surface model to point
data. The data are fed to an actuator consisting of numerically controlled three axes table. The actuator for representing the shape of surface arranges discrete pins in a reconfigurable mould. An elastomer sheet is used as an interpolation layer over the discrete pins. The reconfigurable manufacturing system (RMS) includes vacuum forming process for manufacturing lens.

The fourth part of this work deals with a framework for product data management (PDM) system. It allows the product development team to create, update and delete data pertaining to the user domains.

This work is a systematic study carried out in constructing a framework that can be further developed into a PDM solution as needed by OEMs involved in the design and development of headlamps used in passenger cars. In all the phases of product development, users create/update/delete information. The use of workflows is not attempted here which can be incorporated by subsequent upgradation of this work.