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Significance of Concurrent Engineering Methods used in Automotive Industries

Mukesh Kumar Nag

Mechanical Engineering Department, National Institute of Technology Jamshedpur

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Abstract - The importance of Concurrent Engineering is rising as businesses compete in the global market. The primary variables that influence a company's success are the reduction of time spent on product creation, the improvement of product quality, the reduction of production costs, and the satisfaction of consumers. The idea of Concurrent Engineering has to be put into practice if high-quality goods are to be produced. It is a methodical strategy that succeeds when all design tasks are combined and carried out simultaneously. Many businesses' product development processes have been overhauled as a direct result of the Concurrent Engineering strategy. Therefore, the purpose of this study is to analyze the use of Concurrent Engineering in the automobile sector by reviewing its fundamental ideas and tools. In the same way, doing a thorough market study and meticulously planning every step of the design process are essential in a Concurrent Engineering setting. By keeping "avoidable" expenses out of the design in the early phases, the Concurrent Engineering method may lead to substantial savings. It is also sometimes called "Simultaneous Engineering."

Key Words: concurrent engineering, product quality, production cost, automotive industries

1. INTRODUCTION

The conventional method of product development in the automobile sector was characterized by divisions of expertise and narrow job descriptions. Each step had to be completed before moving on to the next, and the processes generally followed that pattern [1]. This strategy required several changes to be made late in the product development cycle, which was not only costly but also time-consuming and challenging. There is now increased pressure on the automobile industry to produce high-quality goods quickly, cheaply, and to the satisfaction of more discerning and demanding consumers [2]. Large corporations or original equipment manufacturers (OEMs) have devised and deployed a concurrent engineering (CE) strategy to address the aforementioned issues [3].

To improve communication and collaboration across the whole product development process, CE works to break down barriers between departments. It motivates experts across disciplines to pool their expertise and experience in problem-solving for the project [4]. By getting everything rolling simultaneously, quickly, and smoothly, CE speeds up the whole product development cycle [5]. Although the time spent on the design process as a whole is greater when using CE as opposed to more conventional approaches, the final result is a higher quality, more clearly defined product that can be produced in less time [6].

These days, it is common practices for corporations to hire outside firms to handle complex engineering projects so that the in-house engineering teams may focus on their core competencies. This has led to a new issue, since smaller suppliers are unable to keep up with the competition by using innovative methods like CE and technology like computer-aided engineering (CAE) [7]. This may be particularly costly for smaller suppliers that work with several original equipment manufacturers (OEMs) who each have their own preferred methods and CAE software. The purpose of this project is to suggest and execute a CE framework tailored to the needs of the automobile industries and suppliers.

2. Problem Identification, Objectives, Scope, and Benefits

Problem Identification :

a) Problems with the vehicle's design, quality, and manufacturing process were going unaddressed, which lengthened the production schedule and caused delays in delivering the finished product.
b) Reducing and communicating complexity the proliferation of vehicle types has led to the production of several mechanically identical components and fasteners, creating redundancy and adding complexity and expense.
c) Facilitated Organizing Delays in vehicle clearance, improperly fitting components, and quality concerns all resulted from a failure to strictly adhere to the Change Matrix, Issue Capturing and Resolution System, and Bill of Materials Compliance reports.

Purpose :

During the product design phase, ensure a smooth rollout by digitally addressing any "Manufacturability or assembly feasibility potential concerns" and considering all of the factors essential to achieving high quality and consistent results in the manufacturing process.

Scope :

a) Problems with design or production may be solved digitally at the DR Gateways facility.
b) Parts with identical specifications and functionality that have been issued by the ERC should be communicated or suggested as alternatives.
c) In order to create a statement of requirements, it is necessary to create a bill of materials that complies with the specifications.
d) Problem reporting, tracking, and resolution via a central monitoring system.

e) Interaction with ERC, TS, PLD, etc., to solve significant issues, raise SORs, etc.

Benefits :

a) Saving time and resources in the long run by preventing the release of identical components and fixing design and process problems during the DR phase.
b) A heightened spirit of collaboration and initiative amongst departments and organizations.
c) More Rapid product rollout is possible with a system-based monitoring strategy.
d) Lessening of subsequent vehicle-dropping-stage rework.

3. Designing Release Gateways while using Concurrent Engineering

There are different stages of the design release gateway for Concurrent Engineering (From product strategy and planning phase to product ramp up phase) as shown in Fig 1. This is the example of heavy vehicle truck designing release gateway using Concurrent Engineering. The normal designing gateway consume more time as compare to CE [8]. Concurrent Engineering act as a parallel agency to validate and rectify these critical issues that comes in different phases like in DR-2 phase with an intent to eliminate rework, additional costing & extended time frame for smooth vehicle productionization. Any types of issue at any stage can be quickly identify and immediately rectify in this process with less consumption of time. Hence this Concurrent Engineering of a collaborative work of different stages/phases or concerned departments make it productive for the release of the new quality product smoothly in specify time frame of customer demand [9] .

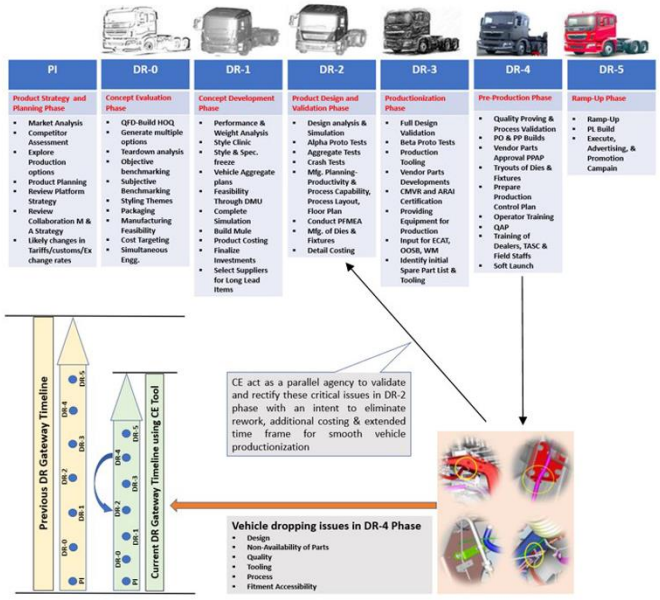

Fig -1: Various Design Release Stages of CE for HV

4. Concurrent Engineering – Workflow

CE acts as a parallel agency to validate/rectify these critical issues in DR-2 stage with an intent to eliminate rework, additional costing & extended time frame for smooth vehicle productionization as shown in Fig 2.

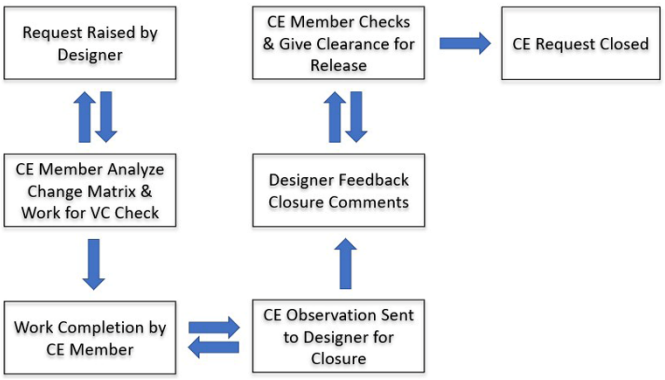

Fig -2: Standard CE Flow Diagram at DR-2 phase

4.1 Concurrent Engineering – Design, Electrical, Process Check, and Validation

In the concurrent Engineering the Design, Manufacturing and Assembly, Electrical check, Accessibility, Complexity reduction, and Bill of materials compliances have been incorporated. At every stage a proper identification and rectification and documentation have been generated simultaneously as shown in Fig 3.

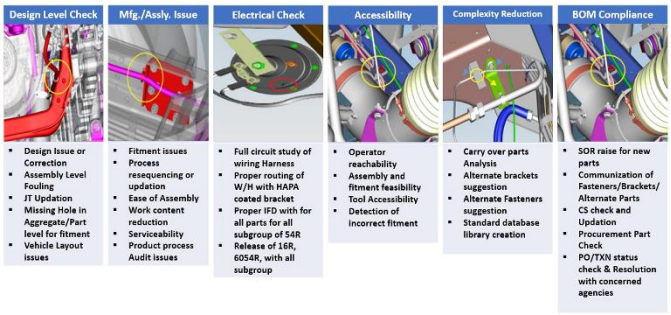

Fig -3: Various Stages of Concurrent Engineering

4.2 Concurrent Engineering – VLO checking guidelines

VLO refers to Vehicle layout which consists of all electrical harnesses made up of wires and air lines made up of nylon pipes, battery cables, fuel lines, coolant lines etc. Proper gap should be available in design in such manner that there should be adequate clearance during physical vehicle build. Few VLO guidelines are to be kept in mind while designing which are listed below in Table 1.

Table -1: Vehicle Lay-out Valuation for Different System

Vehicle Lay-Out Valuation			
Demerit Guidelines			
Score	Functional Defect	Score	Aesthetic Defect
100	Very Serious (Safety)		
40	Serious (Vehicle Stop)	20	Working Disturbance
10	Significant	1	
Fuel Feeding System			
Clearance (mm)	Conditions		Controlled Condition
50	From Rotating & Moving Parts (Flexible Pipelines)	Note-1	Less distance is generally allowed in presence of electric cables with fuse and or with spacer clamps that avoid the contact
25	From Rotating & Moving Parts (Rigid Pipelines)		
100	From electric system parts (Nylon and Rubber pipelines) (Note-1)	Note-2	50% reduced distances in presence of protective shield or sheaths
50	From electric system part (Metallic pipelines) (Note-1)		
200	From exhaust pipeline (Note-2)		
300	From earth to underbody ducts (Note-3)	Note-3	Less distance is allowed if pipelines are at least 3mm over the plane formed by the floor (cable trunking) or if they are equipped with an appropriate rigid shield along the whole underbody path.
100	From battery		
100	From Alternator and starter. Fuel pipes junctions in the area overhauling the alternator are not allowed. In presence of appropriate protections less distance is eventually allowed.		
Electrical System			
Clearance (mm)	Conditions		Controlled Condition
50	From Rotating and Moving Parts (Note-1)	Note-1	Distance can be less if highly reliable fixing or appropriate shields/protections are present.
50	From braking system components (Flexible pipes and tanks) from oil pipelines (Note-1 & 2)	Note-2	On the above-mentioned pipelines electrical cables are not allowed.
50	From Engine block and Radiator (Note-1&3)	Note-3	The sensors cables and the related devices have to be considered exceptions.
100	From Manifold and Exhaust pipelines (Note-4)		
100	From injectors, tanks, from canalizations and from fuel pumps (Note-1,2&3)	Note-4	The distance can be less if anti-heating barriers, high thermal performances cables or heat reflecting sheaths are provided as protection.
200	From Catalytic mufflers (Note-4)		
Breaking System			
Clearance (mm)	Conditions		Controlled Condition
Rigid Pipelines			
0	Absence of contact between pipes themselves and with other adjacent non-moving elements.	Note-1	If this distance is not maintained, it is necessary to utilize a plate shield in order to protect the pipeline.
5	From fuel flexible pipelines and electric system		
50	From Rotating or Moving Parts (Note-1)	Note-2	The indicated Distances can be less in presence of an appropriate heat protection/shield on the pipeline
200	From Manifolds, Exhaust pipes, and from Silencers (Note-2)		
200	From Catalytic mufflers (Note-2)	Note-3	Less distance is allowed if
300	From Earth for underbody pipelines (Note-3)		pipelines are at least 3mm over the plane formed by the floor (cable trunking) or if they are equipped with an appropriate rigid shield along the whole underbody path. Shield must permit an easy evacuation of water or mud in order to avoid corrosion.
Flexible Pipelines			
50	From Rotating or Moving parts (Full tested with spacers) (Note-4)	Note-4	This condition must be verified with the wheel in all the shaking jolting and steering conditions with and without snow chains.
15	With other non-moving adjacent elements (5mm when the contact is prevented by a concrete constraint).		
25	From Heating sources or Braking drums (Note-2)		
Steering System			
Clearance (mm)	Conditions		Controlled Condition
15	From fixed parts (Reduction to 5mm in presence of full proof fastening clamps. The contact is allowed if a pipe protection is provided).		
25	25mm from moving parts or components (Reduction to 10mm if appropriate protections on pipes is provided).		
120	From Exhaust pipelines (This distance can be less if protection sheaths or appropriate shields are provided.		
For Other Systems			
The criteria described above are valid for engine cooling (water, air, oil) passengers compartment conditioning/heating and accelerator, clutch, engine hood/trunk opening etc. mechanical cable.			
Belts and moving parts: Must be protected from splashes of mud, salt and rain and cannot constitute a danger for maintenance operator.			

4.3 Concurrent Engineering – Communization and Standardization

Communization of designs can save development time and money and reduce manufacturing costs, as well as customer service and inventory costs. Standardization means to design items with generally accepted and uniform procedures, dimensions or materials [10]. Communization and Standardization benefits are: - lower supply chain costs, faster product design, less variety of suppliers, a smaller number of production operations, interchangeability, easily available in aftermarket etc.

Hence Concurrent Engineering captures and guides to use standard parts which are readily available without any tool investment. It also focuses on use of communizing and using already developed parts. Some of the standardize parts are shown in Fig 4.

Fig -4: Various Stages of Concurrent Engineering

4.4 Concurrent Engineering - Bill of Materials Compliance

It involves checking of complete Manufacturing Bill of Materials to ensure error free and complete Bill of Materials (BOM) transfer to SAP without any Purchase Order and transaction error. CE work also includes generate compliance rollup reports for the BOM and identifying alternate parts for non-compliant parts. Table 2 is an example of what a Bill of Materials report may look like.

Table -2: BOM Compliance

Item/Group Number	Item Name	Modification
G34847	Grp. Part wing Screw M6X16 IS3727-4.6-SS84	ERC-Wing Screw can't be developed, Supplier regretted-11405606161 PDC-TBD
12655096017	Washer A8.4 IS5370 ST SS8451S2-B	Use alternate Part- 12650600841
11347596681	H/F Screw M8X25 TS17071 8.8 SS8457S1 -BL-B	Use alternate Part-11325696283/11341708259
257375108216	Packing Plate	ERC modify surface protection from SS:9400 to Oil Condition
259261110114	Sub Structure Assembly with Floor	Raise SOR
269881900101	Assy. Clip Black 17Dia	Part of canopy to be deleted
257675207501	Bush Centre Flap	Part not require/Part not fitted, to be deleted from BOM
G37176	Grp. Part assembly wiper Arm and Blade (Offer)	ERC Correction/Raise SOR
277082400106	Assy. Wiper Arm and Blade (M/s-BCS)	ERC has agreed to release, deviation copy attached in MINT
277082400105	Assy. Wiper Arm and Blade (Offer)	Raise SOR, Drawing not available
G37179	Grp. Part Assembly Wiper Arm and Blade (Offer)	ERC Correction/Raise SOR
261882400111	Assy. Wiper Arm and Blade	ERC Correction
265182400128	Assy Wiper Arm RHD (M/s-Bombay Synd.)	Duplicate release with 2157054382R (Updated in MINT)
264382400104	Assy Wiper Blade (600mm length) M/s- BCS	Duplicate release with 2157054382R (Updated in MINT)
261882400110	Assy. Wiper Arm and Blade	Raise SOR, Drawing not available
G44712	Grp. Part accessories Kit for Wiper Motor	ERC Correction/Raise SOR
280882400108	Accessories Kit for Wiper Motor M/s- Prabha	Raise SOR, Drawing not available
280882400107	Accessories Kit for Wiper Motor	Procured along with 00082000037J- Accessories Kit for 17W Wiper Motor (Updated in MINT)
280882400109	Accessories Kit for Wiper Motor TML	Raise SOR, Drawing not available
11220610229	Sealing Washer A14X20 DIN 7603 ST	Use developed Fasteners
278613136804	Coupling Body	Shop part is BOM part +O ring, ERC has agreed to release shop part and correct TPL structure (Updated in MINT)
11406704302	Cross Pan Head Screw M4X30 IS7483 SS8451S2-Y	Use Alternate Part No-11405604258/11405604452

3. CONCLUSIONS

According to the evidence presented in this paper, CE is indeed crucial throughout the creation of a product. Designers may improve the efficiency and effectiveness of production by incorporating the CE idea and its tools into the product development process. Companies using CE tools in product development have reaped significant advantages, especially in the areas of lowered development costs, shortened timelines, higher quality products, and more satisfied consumers. Additionally, utilizing this technique might help lessen certain design concerns and allow for a more open and honest procedure while creating the product. The use of the Concurrent Engineering tool yields beneficial results in terms of the idea as a whole.

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BIOGRAPHIES (Optional not mandatory)

Mukesh Kumar Nag received his B.E in 2014 from The Institution of Engineers (India) and M.Tech from National Institute of Technology Jamshedpur, Jharkhand, India in 2019. Currently he got the Ph.D. position in the Department of Mechanical Engineering at National Institute of Technology Jamshedpur, Jharkhand, India in 2019 and is working on Natural Fiber/Bio-composite under the supervision of Dr. Parmanand Kumar.