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# STUDY AND ANALYSIS ON REDUCTION OF MATERIAL REQUEST AND LINE RETURN IN A VOLVO TRUCK ASSEMBLY LINE

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***Abstract*— Now a days in the world, globalization and consolidation multinational companies results in increased competition for manufacturing plants. A truck manufacturer in India, like volvo, demand from global shareholders as well as the local customers. Assembly is the process for product realization, where component parts and subassemblies are integrated together to form the final products. Quality, cost and delivery are three important parameters, With respect to the vehicle, the low cost, high quality and delivery time plays an important role keeping in mind the end customer.**

**In this paper, a analysis of an assembly process as per product structure. As a result there are materials excess or shortage in an assembly line in a manufacturing plant, due to errors, they may be operation, product structure, or due to local adaptation change in product design etc,. The Reduction of excess or shortage materials in assembly line to improve productivity of a product, by a PDM(Product Data Management) with a standardizing a BOM(bill of materials). .**

***Keywords:* Assembly, product structure, BOM(bill of materials), PDM(product data management).**

## I. INTRODUCTION

A product structure most often forms a hierarchical structure. A traditional mechanical design-oriented definition of a product structure is: A product structure is a division of parts into a hierarchy of assemblies and components. An assembly consists of other assemblies (subassemblies) and/or components. A component is the lowest level of the structure[3].

As every company's design process is specific to the company, a generic reference model was designed that serves as an overall framework for product structure management. Such a general framework is considered a valuable starting point for the vehicle manufacturer as a high level reference was needed to design and deploy, as a company-specific reference model would not have been able to provide a checklist that was sought to ensure a complete and consistent approach.

Product structure definition also describes a bill of material (BOM), which is used in manufacturing to collect all the objects and information for building the final product. The bill of material (BOM), which is a documentation technique on product structure, is used to demonstrate the structure and relations between the final product, subassemblies, as well as the corresponding quantities of the subordinate parts and materials of each assembly [1][2]. A structure model is proposed to record the product tree. Each object in the tree presents itself as a parent item or a child item. There are different forms of BOM during the product life cycle.

In theory, the varieties derived from a product could be in hundreds of thousands. For instance, a truck of common type could be assembled in millions of variants through all possible combinations of its assemblies. However, practically, the diversification of model into variants is limited to those assemblies and final products with few differences [1]. In a customer-oriented environment, generic products replace standardized models. A generic product is defined through a set of attributes, which may have a set of alternatives parts/variants. Since the number of variants may be large, it is difficult to design and maintain a BOM structure for each variant. A solution is to describe all product variants in one generic BOM. The BOM for each product variant may then be generated from this structure by specifying attributes.

A BOM describes the component structure of a product, usually as a hierarchical structure implemented within a relational database. These descriptions include the relations between the end-product, subassemblies, and materials. The conventional approach for the implementation of these structures in an Enterprise Resource Planning (ERP) or a Product Data Management (PDM) system is to design a single BOM for each product variant. However, this becomes impossible in a customer-oriented production, where the generic product is defined through a set of attributes, which may have alternative values or variants[3].

  

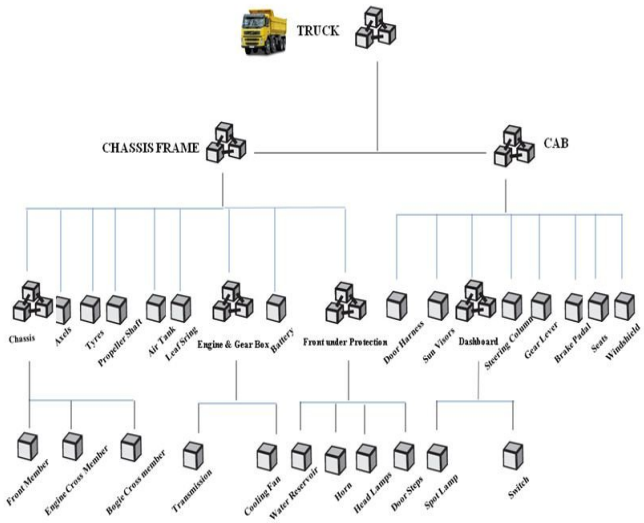


Fig.1. Product structure of Truck

## II. ASSEMBLY

A product, according to Askin R G [4] is "any item that is designed, manufactured and delivered with the intention of making a profit for the producer by enhancing the quality of life of the customer. Most products are made up of various parts, where a part can be described as a single unit of a product that are brought together with others to form the finished product. Assembly, therefore, can be explained as the operation of bringing parts together, either manually by operators or automatically by robots, to form a finished product. Fixing of more complex parts that have more than one component before being assembled to the work-piece as a single unit is called a sub-assembly. A work-pieces an unfinished product whose assembly is in progress.

### A. *Material Request*

The production teams asks for the extra material through the material request slip in a assembly line, the production engineering department validates the request whether the extra quantity is required or not and gives the information to store to supply the part.

Reasons for material request are

1) *Product Structure Error*: A product structure is a division of parts into a hierarchy of assemblies and components. An assembly consists of other assemblies (subassemblies) and/or components. A component is the lowest level of the structure[3]
If the error occurs in a product structure, there may be a chance of shortage of material in a assembly line.
2) *Not given in assembly instruction:* Some time material quantity missing in a assembly instruction but required in a assembly line for assemble, like this error is called missing in instruction
3) *Sprint Error:*
Sprint is global manufacturing system which can used to create Material structure and Assembly instruction on a factory. *Material structure* - used by logistics for breaking down the material for a truck.. *Assembly structure* – used by Production Engineering department to create assembly instruction reports to the operator.

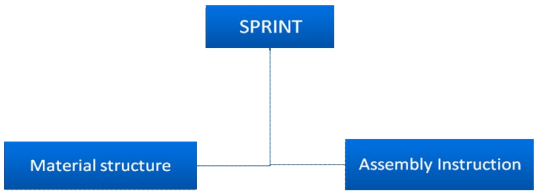


Fig. 2. Sprint

The *Sprint* is a document that gives the details of the assemblies performed in each station like the operations, core instructions, and part locations and part quantities. If there is error in quantity or less number of quantity given in document than its considered as *sprint error.*

4) *LA Requirement:* The global manufacturing company will have single design of a model throught globally but a design product will little change geographically location because to achieve requirement of local needs, this is called LA(local adaptation) Requirement.
5) *AD Parts:* AD parts those which are required after a kit parts reach a plant but some extra parts required in a assembly line.
6) *PE Error:* The assembly structure validated by a Production Engineer but have chance of occurrence of error by production engineer, this type is called PE Errors.

TABLE I
MATERIAL REQUEST DATA IN VOLVO GTO

| | Sep-13 | Oct-13 | Nov-13 | Dec-13 | Jan-14 | Feb-14 | Mar-14 |
|---|---|---|---|---|---|---|---|
| STRUCTURE ERROR | 3 | 4 | 7 | 0 | 0 | 0 | 1 |
| NOT GIVEN IN INSTSRUCTION | 31 | 27 | 18 | 16 | 13 | 9 | 5 |
| SPRINT ERROR | 21 | 15 | 19 | 13 | 9 | 8 | 4 |
| LA REQUIRMENT | 3 | 4 | 4 | 2 | 0 | 0 | 0 |
| AD PARTS | 0 | 5 | 3 | 11 | 7 | 6 | 4 |
| PE ERROR | 1 | 0 | 0 | 0 | 0 | 1 | 0 |

  

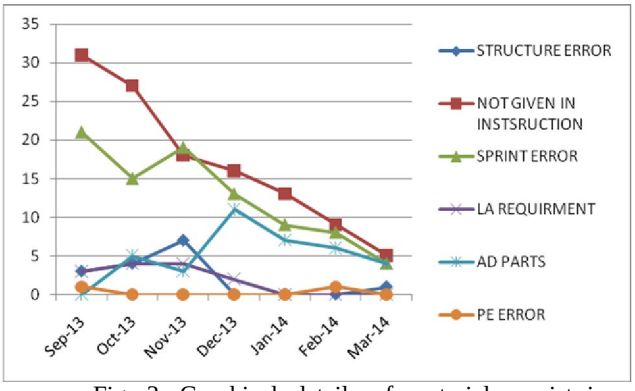


Fig. 3. Graphical details of material requist in a assembly line month wise

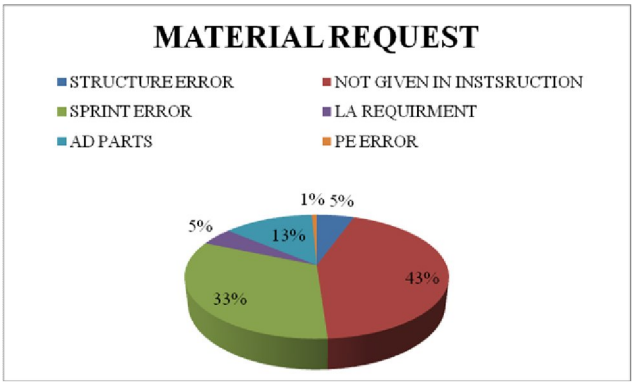


Fig. 4. The material request percentage of error individual parameter at Volvo GTO

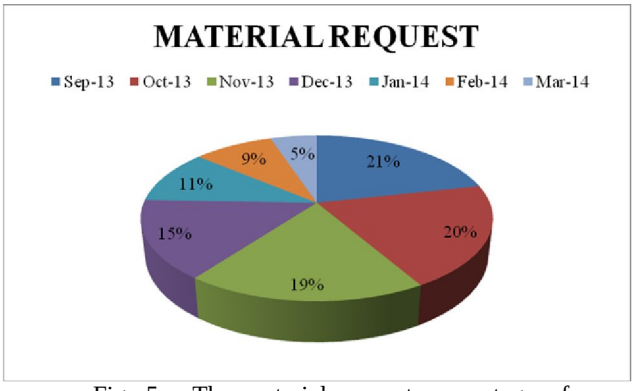


Fig. 5. The material request percentage of error month wise

B. *Line Returns*

After the completion of the batch in a assembly line, the parts are sent back as a line return. The production engineering deportment will validates the parts which are line returned and gives decision whether to scrap or to store for future use.

*Batch:* The batch is a specified quantity of truck order which to be assembled, quantity will be fixed, for example in Volvo India Pvt Ltd, for each batch fixed a 25trucks.

1) *Product Structure Error*: A product structure is a division of parts into a hierarchy of assemblies and components. An assembly consists of other assemblies (subassemblies) and/or components. A component is the lowest level of the structure[3]
   If the error occurs in a product structure, there may be a chance of excess of material in a assembly line.
2) *Wrong variants order:* The wrong variants which order, can't be use in a assembly line for final product, those materials come under a line return and will be given for scrap.
3) The *Sprint* is a document that gives the details of the assemblies performed in each station like the operations, core instructions, and part locations and part quantities. If there is error in quantity or excess number of quantity given in document than its considered as *sprint error.*
4) *AD parts/S-note:* S-note is a special condition due to inner liner the parts are taken a deviation because of short length, the error will be faced due to deviation in a assembly line.
5) *PE Error:* The assembly structure validated by a Production Engineer but have chance of occurrence of error by production engineer, this type is called PE Errors.
6) *Packing/Excess Issue:* The logistics management will supply the material to assembly line, while supply excess issue or packing in a kit leads to line return after completing a batch .
7) *Wrong Operation:* The wrong operation by a operator also leads to a line return because operator may used different parts for a operation so which to be actually used may come in line return.

  

TABLE 2
MATERIAL LINE RETURNS DATA IN VOLVO GTO

| LINE RETURNS | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sep-13 | Oct-13 | Nov-13 | Dec-13 | Jan-14 | Feb-14 | Mar-14 |
| STRUCTURE ERRORS | 14 | 3 | 1 | 0 | 2 | 4 | 1 |
| WRONG VARIENT ORDER | 1 | 9 | 13 | 10 | 4 | 2 | 0 |
| SPRINT ERRORS | 79 | 72 | 80 | 62 | 39 | 24 | 13 |
| LA REQUIRMENT | 24 | 21 | 6 | 3 | 2 | 4 | 0 |
| AD-PARS/S-NOTE | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| PE ERRORS | 1 | 0 | 0 | 0 | 5 | 3 | 0 |
| PACKING/EXCESS ISSUE | 105 | 69 | 108 | 158 | 43 | 57 | 28 |
| WRONG OPERATION | 12 | 6 | 11 | 10 | 3 | 3 | 1 |

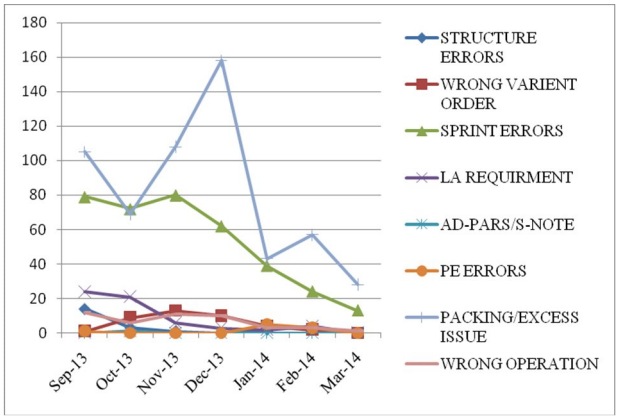


Fig. 6. Graphical details of material line returns in a assembly line month wise.

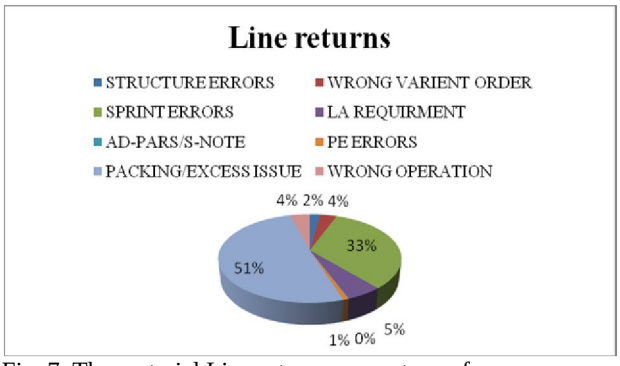


Fig. 7. The material Line returns percentage of error individual parameter at Volvo GTO

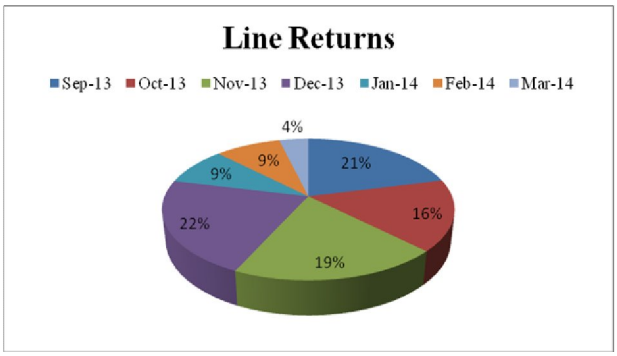


Fig. 8. The material request percentage of error month wise

## III. METHODOLOGY FOR ANALYSIS

A. Steps used in methodology for analysis
1) Validation of Assembly instruction with Assembly process
2) Identification of issue
3) Analysis of issue
4) Analyze the root cause
5) Feedback to International Manufacturing Team
6) Implement
7) Evaluate results and processes

B. Objective of study
1) To study the Product structure of Truck.
2) To study in detail Design & the existing assembly process of Truck.
3) Identification of Problems or Errors in a Assembly , Design or Assembly process.
4) Analysis of problem and solution to problems.
5) Reduction of Shortage or Excess of material in a assembly line in Production by standardizing a BOM(Bill of Material).

C. Software tools used by Production Engineering

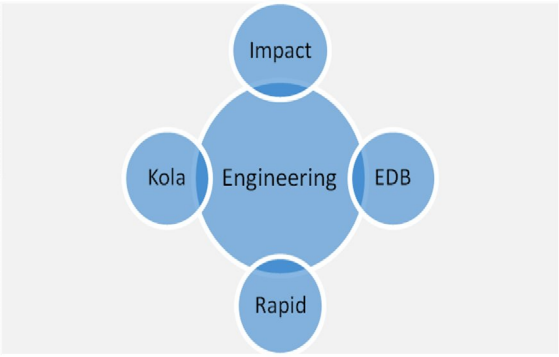


Fig. 9. Software tools used my a production engineer in production

  

**1) Rapid:** the rapid tool has information about the part drawings and technical requirement of the parts.

**2) Kola:** stands for konstruktions data lastvagnar (full details of truck) the kola is the important tool used by the engineering team.

It has information about

a. Product class and product types
**b.** Variant and the related parts to that variant.
**c.** Parts related information.
**d.** Cad drawings.
**e.** Technical information.
**f.** Design change information.
**g.** Parent and child parts.
**h.** Part documentation

**3) EDB:** stands for engineering data base. This tool has the information about the complete variant description of the truck. Ex: - truck engine, wheel base, steering wheel position etc…

**4) Impact:** is generally an aftermarket tool but it is also used by the engineering. It has the information about the physical location of the part in assembly, screw's to be used, torque values etc.

**5) Protus**: Proto type follow-up is used for prototype development and gives information about prototype structure. It is also used by production, purchasing and aftermarket teams. The engineering team uses this tool to raise the design issues of a part and follow-up until the clarification is done.

D. Flow chart for analysis

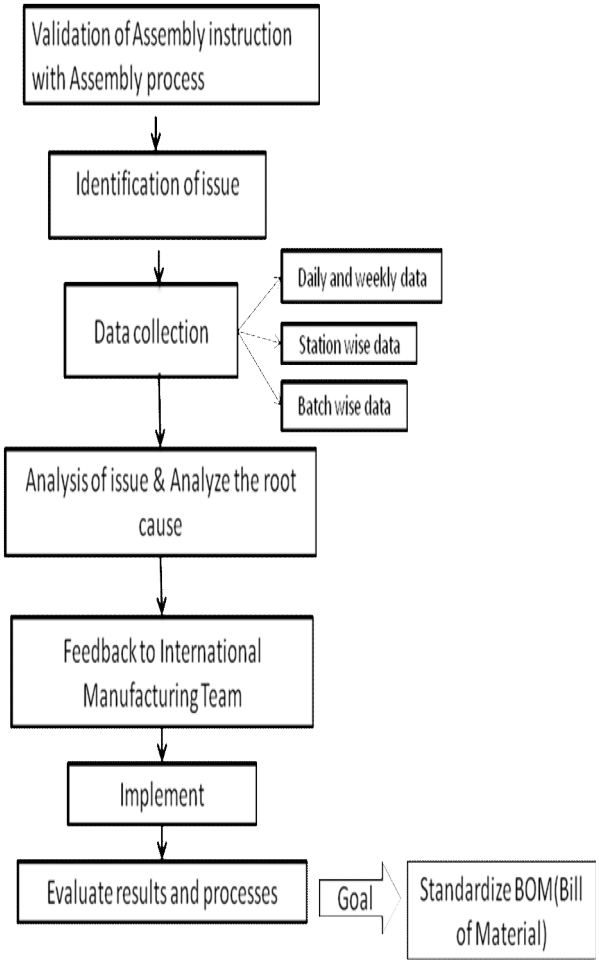


Fig. 10. Flow chart for Analysis of material request and line return in a assembly line

## IV. CHANGE APPROVAL

A. PDM(Product Data Management)

The global manufacturing companies will have a server one place of location and working station will be in a different geographical location and data will be extracted from a server or also can be modified and saved in a sever. The whole process will be done through PDM(Product Data Management) .

The domain managing such product data during the product's entire life cycle is called PDM[5]. PDM is an engineering discipline that includes different methods, standards, and tools. First, it manages data related to products: structures of the products, including lists of their components and product configurations that identify all

  

components and documents versions belonging to a particular product version. Second, it supports procedures during the PLC. PDM also deals with the development and production infrastructure, which means that it provides information for all activities[3][5]. This means, for example, that PDM does not include design methods, but makes possible the availability of all information needed for a successful design process. Traditionally, PDM deals with hardware products, while it usually has not been used in development of software products.

Product Lifecycle Management (PLM) and Product Data Management (PDM) integrate different processes across a company via a common IT system and aligned methods. Product Data Management systems are the most important part of PLM strategies, as they serve as its key component to manage all product data and related workflows[7]. PDM systems make necessary and relevant product data available in each part of the design process and for each participating role throughout the whole life-cycle of products. A consistent product structure model forms the core to such a system[6]. To this product structure model, representing the architecture of the products that are managed in the PDM / PLM system, all additional data such as CAD files, process descriptions and more are associated.

B. Data Distributed in Environment

To be able to perform distributed development, where project team members are located at various geographically dispersed sites, data has to be available at all of the sites. This must be done in a controlled way to avoid inconsistency of data. PDM systems have distributed replicated databases, in which it is possible to replicate metadata or both metadata and files throughout the network, as shown in Figure. In a distributed environment, administration and user data is always replicated. Other metadata is replicated as needed. Files (data items) are also replicated as needed. Performance problems are distributed by event-driven replication. For example, if a change is performed and a check in is done, the changed document will not be distributed to all other servers until a query is done to avoid unnecessary network load.

C. Workflow for change approval

All documents in which work is in progress are stored in the WIP vault. A work order is sent to the designer when review is necessary. The designer sends the document to designated users for reviewing. The change review board will take care of the comments. When the document is approved, it will be stored in the release vault. Upon approval, the new and modified documents and all data are sent from the WIP to a release vault, and the item now revised becomes generally available. After the work is completed, the newly revised items continue to refer to the work instructions and work orders by which they were generated. This provides a valuable history of the evolution of the design, which allows users to learn from design approaches that have been implemented in the past[3].

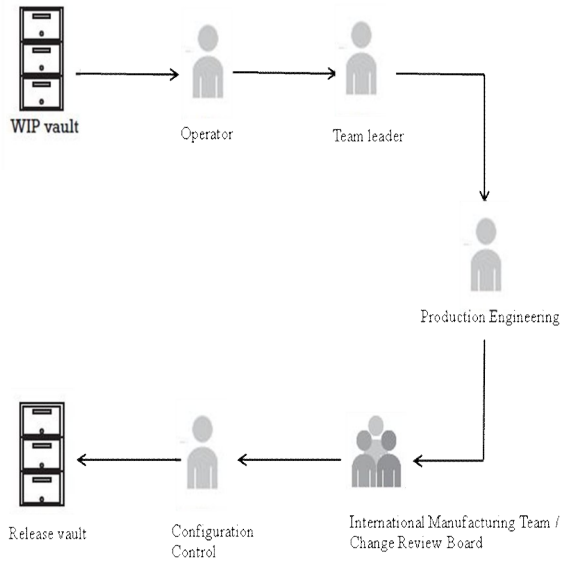


Fig. 12. Workflow for a change approval.

D. Bill of Materials(BOM)

The bill of materials (BoM) is, in its simplest form, a list of parts or components required to build a product. It provides the manufacturer's part number (MPN) and the quantity needed of each component. At its most complex, the BoM is a multi-level document that provides build data for multiple sub-assemblies (products within products) and includes — for each item — part number, approved manufacturers list (AML), mechanical characteristics and a whole range of component descriptors. It may also include attached reference files, such as part specifications, CAD files and schematics[8].

Bills-of-material (BOMs) constitute an important part of product modeling information which is used in industry. However, bills-of-material can easily become untenable for companies that increase their product variety, with the aim of improved customer satisfaction. This may easily lead to a situation where the amount of bill-of-material data grows exponentially. This situation does not only stem from the sheer volume of the data but also from the fact that these data are needed almost everywhere in the factory, e.g. in: marketing, product development, demand forecasting, sales and order-entry, material procurement, assembly, physical distribution, and testing[9].

  

## V. RESULT

The result in this research paper shows that the reduction material request and line return can be achieved with 79.34% & 81.77% respectively in a VOLVO GROUP TRUCK ORGANIGATION of Volvo India Pvt Ltd. By a standardizing a bill of material with eliminating 80.54% Error of total number of an Error.

## VI. CONCLUSION

The problem faced in manufacturing company at Volvo group truck organization at India, is material excess and shortage in a assembly line due to error in a Bill of Materials(BOM) and other factors, as we know assembly is a final process of product production or manufacturing so these kind of problems effect production cost, quality and delivery time so these problem must be eliminated before production after prototype at a plant at a time of homologation.

The homologation is a process in a global manufacturing company, a new model will be taken in consideration that the truck will adapted as local customer requirement with little change in product design as a global manufacturing company follow same design all over world.

So at the time of homologation these errors can be identified and eliminated, these problem can't occur in assembly line, like this we can improve a productivity in a manufacturing system.

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