

Development Of Computer Aided Part Coding System For Bus Body Building Industry

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Abstract: In India, a positive growth trend is observed in city and luxury bus markets. The demand for commercial bus building is also high throughout the year. The bus body building industry is still highly unorganized. The problem chosen is of bus body building industry involving 3000 parts which are grouped in 18 part groups. All activities such as vendor sourcing, procurement, shipping, inventory and warehouse management are centred about the part coding system. The concept of Group Technology and coding system has been developed in this research. An automatic part code generating tool that can be commonly used in any bus body building industry has been developed with user friendly GUI. It is a computer assisted part code generation system, which exactly reflects the geometrical and physical features of the parts avoiding duplication. The output code can be easily plugged into the custom programs. This also provides the benefit of grouping similar parts in the warehouse, belonging to obsolete / excess / non-moving categories, together in order to dispose it by suitable method either sales or recycle. It is to be stated that the implementation of this system could enable the bus body manufacturers especially in India to improve inventory management across their companies and possible method of reverse logistics.

Keywords — Bus body building, Graphical User Interface, Group Technology, Inventory, Part coding system, Warehouse management

I. INTRODUCTION

Indian bus body building segment has observed a rapid growth in the commercial vehicle segment. A positive growth trend has been observed in the markets for city and luxury buses. Also the demand for commercial bus building has been high throughout the year. In India, the chassis has been manufactured by vehicle manufacturers like Ashok Leyland, Tata Motors, Eicher Motors and Swaraj Mazda, while bus bodies are built by small/medium scale builders. Till recently, there were no regulations governing the design and building of bus bodies. The bus body building industry has been still highly unorganized. They have not been provided with the requisite infrastructure to build bus bodies adhering to safety standards. As in any other developing economy, in India safety measures for bus body building have till now not received the importance they deserve. With the entry of global bus manufacturers like Volvo and Mercedes and with Indian manufacturers like Tata Motors and Ashok Leyland getting aggressive in this segment, a lot of importance is now attached to the design and quality of buses as well as the safety and comfort of passengers [8].

II. FEATURES OF PART CODING

All activities such as vendor sourcing, procurement, shipping, inventory and warehouse management are centred about the part coding system [1], [5]. These activities are

carried out with reference to the part codes [6], [9]. A code may be numbers (numerical) or alphabets (alphabetical) or a hybridization of numbers and alphabets (alphanumeric) which are allotted to the parts to process the information [3]. Structure of Coding system may be either hierarchical or chain type or hybrid mode (Combination of chain and hierarchical type) and polycode [2], [4]. Reference [3] have claimed that part families could be established more realistically by practicing the classification and coding of parts due to the advantage of using the manufacturing and design attributes concurrently. Part includes wide range of tools for controlling business processes, transactions and managing vendor relationships [7].

FMCG products and larger companies often use long and complicated numbers for their part numbers. But if there is a need to create a system that's easier to work with and uses own part codes, a systematic step-by-step procedure must be adopted to have a standard part code which is meaningful. These types of part codification system must satisfy the following requirements [4]:

- 1) The letters that can be confused with numbers like O, I, and L must be avoided.
- 2) A manufacturer's serial number or part number should not be used since these numbers are often too long and cryptic. Also if manufacturer changes their number, it becomes meaningless.

- 3) Part codes must be short.
- 4) Few alphabets must be used which help distinguishing the part codes from other codes, and it will further increase the number of possible part codes keeping the overall item number length as short as possible. Using a few letters from the beginning of part description at the beginning of part code will make it much easier to look up items in pick lists.
- 5) Part numbers must be simple and alphanumeric.

III. GROUPING OF BUS BODY BUILDING PARTS

Indian bus body building industry has been producing multiple variety of bus bodies, because these have been oriented fully towards requirements or specification dictated by the customers. Different materials used in bus body building industries have been broadly grouped into raw materials and fabricated materials.

Around 3000 variety of parts have been used for building buses. These parts are used under different stages of assembly. Considering the physical and geometrical attributes of parts, these are falling under different varieties. These parts are falling under different groups which are shown in Table 1. The complete database has been stored in MS-Excel, a data base spreadsheet associated with windows operating system.

Table 1 Parts grouping

Sl.	Group	Part groups
1.	MS	Mild steel
2.	SS	Stainless steel
3.	GI	Galvanized Iron
4.	AL	Aluminium
5.	PW	Plywood
6.	TI	Timber
7.	RX	Rexin
8.	PA	Paints
9.	CU	Cushions
10.	GL	Glass
11.	AE	Auto Electricals
12.	RG	Rubber goods
13.	LS	Laminated sheets
14.	FA	Fasteners
15.	DM	Door Materials
16.	PV	PVC Items
17.	CH	Chemicals
18.	IN	Insulation

IV. MODEL OF PART CODING

The model of part code is derived from the major group and related sub-groups of parts. The associated features of each group vary from one another. Bus body building involves four stages namely shelling, panelling, furnishing and finishing.

and finishing. Parts meant for each stage are mostly specific and not being used in other stages. Hence the part model is created according to the usage of parts in respective stages as shown in Figure 1.

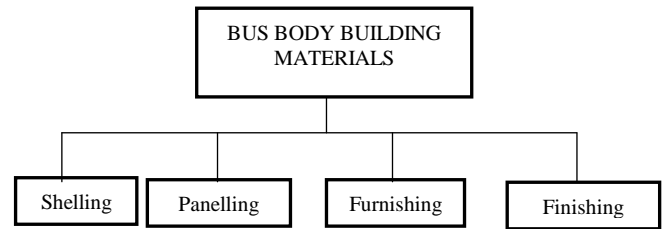


Figure 1 Classification of bus body building materials

Shelling stage of bus body building involves construction of skeleton structure on chassis. Metallic materials are mostly used in this stage of operation. It includes mild steel, Aluminium, stainless steel, galvanized iron etc. These materials are received in different forms such as angle, channel, flat, joist, hat-section, sheets, rods, extrusions, coil etc. The texture includes hot/cold rolled and plain/chequered/corrugated etc. Finish of these parts include polished, non-polished and PVC coated. The model showing an elaborated view of parts belonging to shelling of bus body and the associated features is shown in Figure 2.

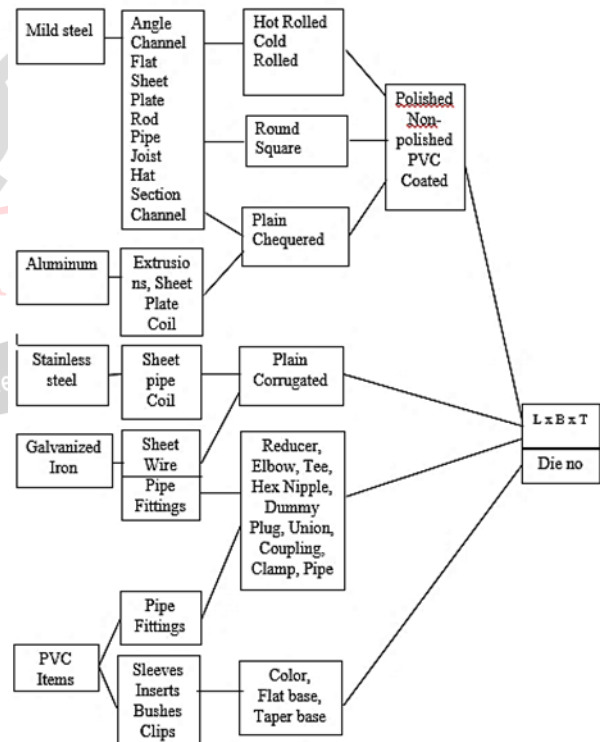


Figure 2 Parts for shelling of bus body

Panelling involves the covering of skeleton structure with timber, plywood, laminated sheets and rexin. Timber is specified by the type of wood, shape and size. Paint items are specified by the Brand and its grade. Rexin items include vinyl mat, carpets for flooring and leather cloth or fabrics for covering the seat cushions. The model showing an elaborated view of parts belonging to panelling of bus

body and the associated features is shown in Figure 3.

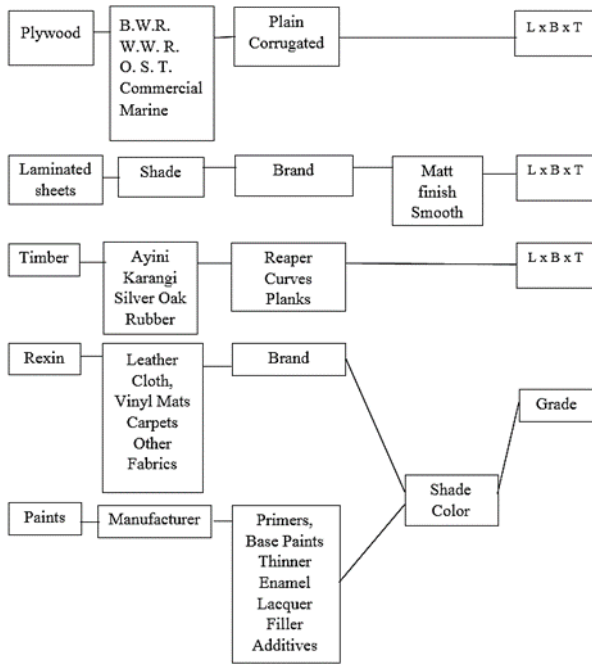


Figure 3 Parts for panelling of bus body

Furnishing of bus body includes cushioning of seats, electrical wiring & fitting electrical items and mounting glasses with the help of rubber beadings. Glasses include all the sub-groups such as processing, shape, colour and size. Auto-electrical items refer to the essential and decorative lighting of the bus body. It includes wires, electrical accessories and bulbs. Rubber goods include beadings or tubular extrusions and sheets belonging to natural and synthetic category. These are mainly used for fitting front windshield glass, window classes and ventilator glasses. Seat cushions are of natural rubber, synthetic foam or coil types. These are made of flat shape or taper shape to be fitted in bottom seat or head rest suitably. The model showing a detailed view of parts belonging to furnishing of bus body and the associated features is shown in Figure 4.

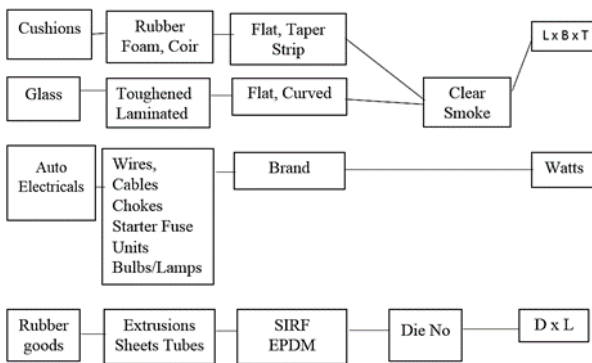


Figure 4 Parts for furnishing of bus body

Fitting is the final assembling stage of bus body which includes fitting of door, cleaning, sealing or pasting stickers and insulating in case of air-conditioned buses. Door materials, chemicals, insulation items and fasteners are

included in this stage. Door materials have wide variety of parts such as locks, hinges, tower bolts, handles, padlocks, door closers and padding items. The model showing a detailed view of parts for finishing of bus body and the associated features is shown in Figure 5.

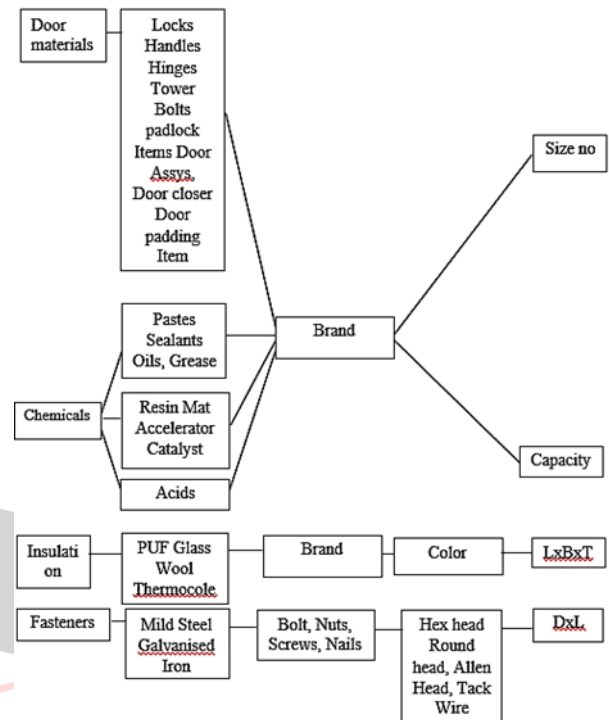


Figure 5 Parts for Finishing of Bus body

Considering the various features of the bus body building parts, a part code model having 9 digits is proposed in this research. A typical part code for a mild steel part is shown in figure 6. It stands for Mild steel / sheet/ plain / polished / 15 x 6 x 2.

1	2	3	4	5	6	7	8	9
M	S	4	5	1	1	5	6	2

Material	Form	Texture	Finish	Size
Mild steel	Sheet	Plain	Polished	Length-Breadth-Thickness

Figure 6 Representation of typical part code model

The part code is modelled with total 9 digits. In this, first two digits are alphabets and other seven digits are numbers. The alphabets correspond to the 18 groups of parts belonging to Bus body building industry. Third digit corresponds to form of the part, which majorly includes sheet, plate, angle, channel, flat, hat section, joist, extrusion, coil, type of plywood or wood etc. Form includes maximum of nine sub-groups under various groups. Hence a single digit is enough to codify form of the part. Fourth digit refers

to texture of part, which includes hot/cold-rolled, plain/corrugated/chequered, round/square, pipe fittings, flat/curved and brand/manufacturer etc. In this sub-group, the varieties are within nine only and can be contained within one digit. Fifth digit is related to the finish of the part that includes polished/non-polished, PVC coated, Matt/smooth, clear/smoke and shade/colour etc. The various types of finish do not cross nine. Hence one digit is sufficient. The last four digits are mentioning the size of the part. Three dimensions of the part can be specified by length X breadth X height, among which length occupies two digits. Size is specified by 'cm' in most of the cases.

V. AUTOMATIC PART CODE GENERATION

The objective of this effort is to generate code based on the user selection. This is involved with step-by-step procedure as per the algorithm shown in Figure 7.

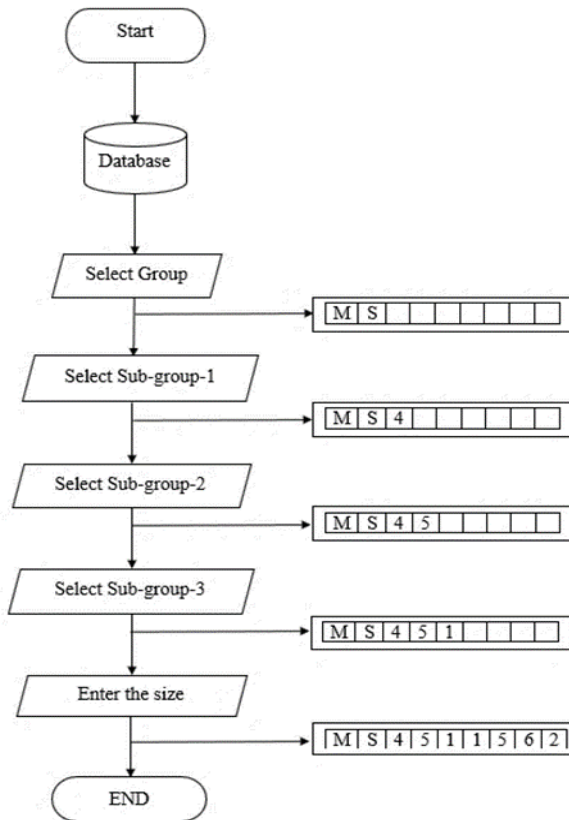


Figure 7 Algorithm of part code generation

Code generator is developed on the simple platform of Windows Operating system using MS-Excel. The salient features of the database and user interface are as listed below:

- 1) Database contains list of part groups and related sub-groups. The values corresponding to each part group and sub-group are also typed in respective columns.
- 2) User interface for automatic part code generator is designed in MS-Excel.
- 3) The entry cells meant for part group and

associated sub-groups are provided with drop-down menu. Based on the list in the database, data validation provides options in the menu.

- 4) At every step, the required options are to be selected from the drop-down menu.
- 5) The value of the select group/sub-group as provided in the database will be generated in the respective cell.

For explaining the capability of this methodology, a typical code is being generated. The methodology followed conforms to the one presented by Reference [10]. The step-by-step selection of options are explained. The various sub-groups chosen under the major group of mild steel and the corresponding code generated automatically has been displayed in Figures 8 and 9. Figure 8 shows the opening screen with the major group to be chosen by the user.

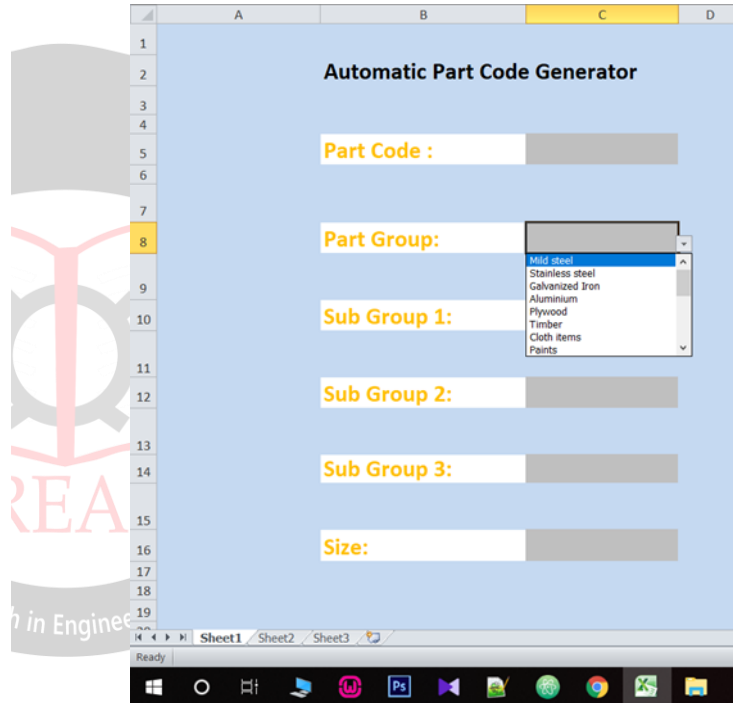


Figure 8 First menu showing the major group of parts

The various sub-groups to be chosen by the supply chain personnel for the selected group of part has been listed. In this display, the list of technical and geometrical attributes for the chosen group has been listed out. These attributes have been varying according to the type of group being chosen as detailed out in the model of part code. In this example, mild steel is chosen. Accordingly "MS" is generated in the cell meant for part code. In sub-group-1, the options corresponding to the form of mild steel are listed. In sub-group-1, fourth option by name 'sheet' is selected. Accordingly number '4' is generated in the part code cell in addition to 'MS'. Also the options corresponding to texture of Mild steel are listed in drop-down menu. In sub-group-2, fifth option by name 'plain' is selected. Accordingly number '5' is generated in the part

code cell in addition to ‘MS4’. Also the options corresponding to finish of mild steel are listed in drop-down menu. The list comprises of two options namely polished and non-polished. This contributes to the fifth digit of the part code. In sub-group-3, first option by name ‘polished’ is selected. The corresponding value equal to number ‘1’ is generated in the part code cell in addition to ‘MS451’. Size of the part is to be entered in this cell. All dimensions are to be entered in 1/100th of m. Hence the length of 1500 mm, breadth of 600 mm and thickness of 2 mm for sheet category is generated as “1562” and added to “MS451”. So, a simple part code of 9 digits long is generated as “MS4511562”. It is shown in Figure 9.

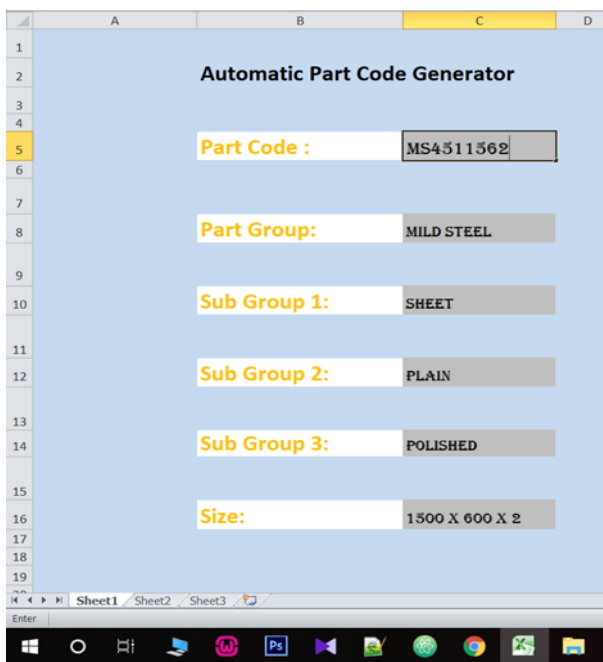


Figure 9 Screen showing the part code generated

The facilities for adding any new category and its geometrical & technical attributes with customizing features has been provided in this tool. According to the need of design and development team, any new material could be added in to the database by this feature.

VI. CONCLUSION

It is concluded that this part coding system highly helps the system operator to generate a new code for a part considering its physical and geometrical attributes under GT. Also the beneficial outcome of this part coding system is highlighted by the following points:

- 1) Reduced cost of IT due to easier understanding by even a layman
- 2) Reduction of data/memory storage characteristics
- 3) Faster operation – higher productivity
- 4) Enhanced trend analysis and business intelligence leading to higher operational performance
- 5) industry-centered application to bus body

building industry

- 6) Possible method of disposal/recycle/resale/remanufacture with the codified information content.

It is to be stated that the implementation of this system could enable the bus body manufacturers especially in India to improve inventory management across their companies and possible method of reverse logistics. The output code can be easily plugged into the custom programs.

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