BILL OF MATERIAL RESTRUCTURING USING A DATABASE ANALYSIS TOOL

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INTRODUCTION

Massey Ferguson Tractors Limited (MFTL) is one of the major tractor manufacturers in the world with a diverse product range of medium, ie. 30-100HP, tractors, sold in 140 countries.

To promote internal customer/supplier focus the Company is split into two manufacturing divisions, the Transmission Division together with the Assembly and Packing Division.

The Transmission Division, consists of, machine shops supplying components to sub-assembly tracks, which in turn, supply rear axles, transmissions and assorted hydraulic assemblies to support the Assembly and Packing Division. The Assembly and Packing Division uses the sub-assemblies produced, together with other bought-out items, to fulfil customer orders for built up products and knock-down (KD) tractor kits.

THE PROBLEM

The bill of material for a tractor is made up from engineering defined "units", some of these units are analogous to actual sub-assemblies but the majority cannot be fully assembled in their own right, only existing as a collection of components within a tractor specification. The units are strung together to form valid end tractor configurations with units providing the building blocks through which Engineering can design 'function' and compatibility. The majority of components within a unit are structured to the 1st level beneath it with very little sub-assembly.

However, the widening product range, together with the multitude of applications has led to high product variability and a resultant growth in unit based bill of material structures. This, in turn, has caused problems due to the bill of material design and maintenance processes having been defined before product variability became so diverse, leading to difficulties in data maintenance, in areas such as design change and routings, slowing 'formal' product change and new product introduction.

The master scheduling section was also feeling discomfort as it had for some time been a company goal to improve the master scheduling process which was being conducted at the end product configuration level. However the bill of material structure was holding back progress in the definition of a meaningful master scheduling 'currency' due to its scale and lack of clarity.

The problems pointed to a badly structured and cumbersome bill of material with a great number of components being structured at the 1st level so creating a large unwieldly set of data.

It was thought that a solution to improve performance would be the restructuring of the bill into a simplified data set that would be, easier to manage, more robust when exposed to forthcoming change and could be used as the basis for master scheduling.

THE SOLUTION

The company-wide drive towards becoming a world class business provided the impetus to create a project team to study the structuring problems. The project team was duly formed with members from engineering, manufacturing and logistics and given the objective of creating a restructured bill of material in the most cost effective manner.

The timescale and resource set for the project team of four months and three men ruled out full product restructuring, but ensured the team would focus on providing results that would derive the maximum benefit for the company and could be easily expanded if required.

This promoted a short but intense debate on the guidelines for restructuring the bill of material and as an initial guide the team took the Dave Garwood approach of 'grouping components by option sensitivity' [1] as a potential solution.

THE METHOD

The method of achieving restructuring was also debated, there was to be little systems resource available so all approaches would have to be based on self-help in the systems area. In hindsight this probably turned out to be an advantage as it gave the team flexibility in method and discounted potentially 'mechanical' solutions, provided exclusively by complicated systems, in favour of less elegant but much more robust practical solutions that, as users, the team could easily explain to other users.

As company strategy MFTL have invested in a 4th Generation Language (4GL) database analysis tool called PC FOCUS, which enables trained users PC access to interrogate and report on data produced from the main company databases in a flexible format. It didn't take the team long to realise that this provided the best method for examining and confirming if option-sensitivity was on a scale, large enough to be exploited.

The first step, therefore, was to examine the product and decide which area of the tractor would contain easily definable, option-sensitive components and would benefit from restructuring. After further discussion it was felt that the Transmission Division would be the best place to explore due to:

i) The units defined within the transmission division could be related to finished assemblies, such as transmissions and rear axles that were delivered to the final assembly tracks and therefore would, as an initial attempt, be easier to conceive and explain to potential users.

ii) The assemblies produced in this division contained some of the largest unit to component structures within the tractor and therefore would derive the greatest benefit from restructuring.

iii) The recognised potential for forecasting and master scheduling Transmission Division products based on the units produced being 'technical-options', ie. recognised by the engineering and sales but not chosen by the customer.

iv) The gut-feel, tinged with experience, that Transmission Division products would show option sensitive characteristics.

The team then had to try and define the type of results expected and how these would be used to satisfy the objectives described. After studying texts on restructuring [1],[2],[3],[4] and after widespread consultation throughout

the company, the team perceived that for MFTL the best result would be the production of a set of common and unique 'modules'. The common modules would have the following definitive characteristics:

i) they would relate to a 'forecastable' sub-set of the product, ie. a set of technical-options

ii) the components contained within them would exist in all applications within the sub-set

iii) the components contained within them would have the same usage pattern within the sub-set

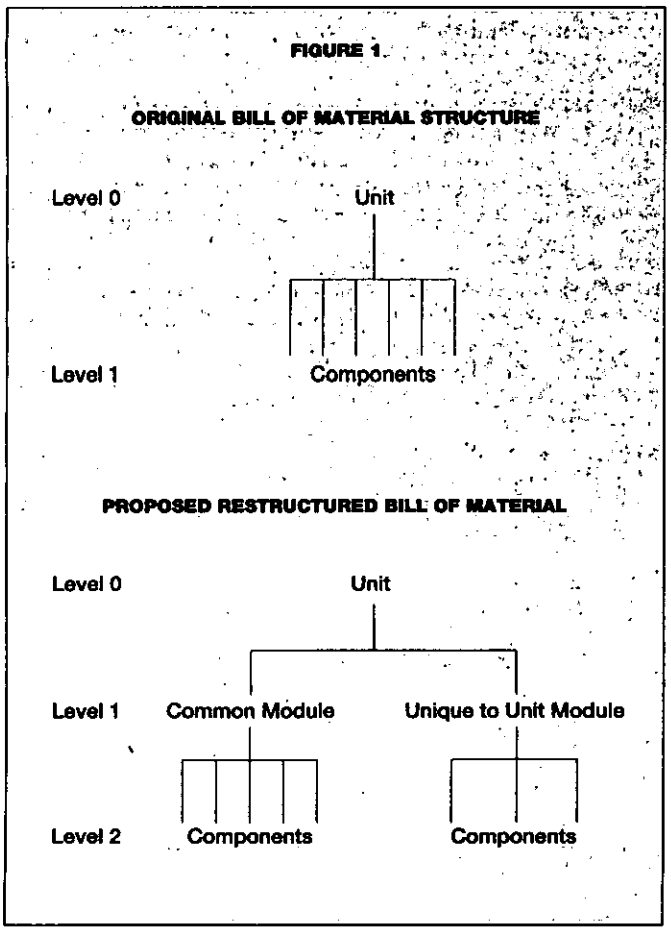
iv) the components contained within them would have the same 'deliver-to' location for shop-floor control information, while striving to maximise the following attributes:

  i) they would contain the majority of high cost components

  ii) they would contain the majority of the long leadtime components.

Any components that existed within a sub-set of the technical-options but did not fulfil the above criteria would be classed as unique and exist in a 'unique to unit' module.

The finalised bill of material would therefore have the structure outlined in Figure 1 and can be compared to the existing bill of material. The modules would simplify the bill structure and allow the classification of original level 1 components into a structure that would provide useful intelligence to user groups about attributes such as module cost and leadtime. All modules would exist as phantoms on the bill of material for use in scheduling and data maintenance only. To minimise the system impacts it was decided modules would not be used for validating compatibility, this being carried out at the unit level.



It was decided to initially try and restructure the transmissions themselves within the Transmission Division products. These were chosen due to their relative simplicity ie. approximately 130 components within a unit, 120 end units and a total part population being approximately 550.

The first practical step was to group transmission units into their optimum sub-sets, christened 'families', that provided the largest common piece-part population whilst also being a realistic forecasting tool.

Based on a best guess coupled with the forecasting requirement the transmission units were grouped into families and their structure exploded and expressed in tabular form using PC FOCUS. The typical output produced is shown in Figure 2 and can be seen to be in a useful format for analysis, with the common and unique groupings starting to become apparent.

The flexibility of the reporting package within PC FOCUS allowed quick response and the ability to iterate until the optimum family groupings were obtained. It also allowed matching of the potential modules to other database characteristics to check costs etc before any of the physical restructuring had been done.

The hard work of analysing the extracts and restructuring the modules then got underway. It was decided that there were 17 natural families within the transmission products each one expressing a set of units as one common module plus a group of unique modules.

One of the main problems was the elapsed time taken to do the analysis and restructuring leading to the possibility of design changes impacting the modules before definition was completed, and so, to counter this, the restructuring took place a family at a time with a design change freeze across the corresponding units while any outstanding design changes were incorporated into the modules.

A spin-off from the restructuring was the identification and correction of both bill of material and deliver-to errors which stood out markedly when existing within a minority of units within the family.

The comparison of units in a matrix form also identified component rationalisation opportunities to increase commonality across the product range through re-design.

THE RESULTS

The testing, evaluating and full restructuring of transmissions was totally completed within the four months and subsequent studies have shown that:

i) The commonality existing within the transmission families as defined is in the range of 70-97% of total family component content.

ii) The ratio of common module to unique module leadtime is in the order of 1/1 - 1.4/1.

iii) The ratio of common to unique module cost is in the range of 3/1 - 15/1.

iv) The decrease in unit to component structures is in the range of 48-86% due to the level 1 links being restated.

This restructuring project has proved invaluable in the development of the master scheduling function within the Transmission Division with the planners now being able to focus efforts on controlling the common modules via direct forecasts from the Market Supply Group while scheduling the unique modules, ie. the variables, via a planning bill of material and two level master scheduling. As can be seen the ratio of common to unique module cost favours this strategy with up to 15 unique modules, ie. the 'variable' factor, being able to be stocked for every equivalent common module.

FIGURE 2

		Units											
		1	1	1	1	1	1	1	1	1	1	1	1
		2	2	2	2	2	2	2	2	2	2	2	2
Components	Description	0	0	0	0	0	0	0	0	0	0	0	0
		0	1	1	1	1	2	2	2	2	3	3	3
PCOMPONENT	PITEM_DESC	9	0	4	5	6	0	2	3	7	2	3	4
897019M1	SHAFT	3	3	0	0	3	3	3	3	0	3	3	3
897020M1	WASHER	9	9	0	0	9	9	9	9	0	9	9	9
897025M1	ROLLER	162	162	0	0	162	162	162	162	0	162	162	162
897065M2	SHIFTER FORK	1	1	1	1	1	1	1	1	1	1	1	1
897367M1	WASHER	2	2	0	0	2	2	2	2	0	2	2	2
899297M1	PLUG	1	1	1	1	1	1	1	1	1	1	1	1
899331M1	HOUSING BEARING	1	1	1	1	1	1	1	1	1	1	1	1
899377M2	BEARING	1	1	1	1	1	1	1	1	1	1	1	1
899385M1	SNAP RING	1	1	1	1	1	1	1	1	1	1	1	1
906472M2	SHAFT	1	1	1	1	1	1	1	1	1	1	1	1
963417M2	SWITCH	0	0	0	0	0	0	0	0	1	0	0	0
964167M1	BOTTOM COVER	1	1	1	1	1	1	1	1	1	1	1	1
964929M1	THRUST WASHER	0	0	0	0	0	0	0	0	0	1	1	0
964944M1	DISTANCE PIECE	1	1	1	1	1	1	1	1	1	1	1	1
1004633M1	O RING	1	1	1	1	1	1	1	1	1	1	1	1
1663655M92	RETURN TUBE	0	0	0	0	0	0	0	0	0	0	1	0
1671558M1	GEAR RING	1	1	0	0	1	1	1	1	0	1	1	1
1671705M1	PINION	1	1	1	0	0	1	0	1	1	1	1	0
1671706M4	PTO GEAR C/M	1	1	1	0	0	1	0	1	1	1	1	0
1672781M2	JAW SELECTOR	1	1	1	1	1	1	1	1	1	1	1	1
1674654M3	SHIFTER FORK	1	1	1	1	1	1	1	1	1	1	1	1
1675274M1	BEARING BALL	1	1	1	1	1	1	1	1	1	1	1	1
1675367M2	SCREW	2	2	2	2	2	2	2	2	2	2	2	2
1677237M92	KIT ZF SYNCHRO	1	1	1	1	1	1	1	1	1	1	1	1
1682688M1	GEAR,1ST	1	1	1	1	1	1	1	1	1	1	1	1
1682692M1	GEAR 2ND	1	1	1	1	1	1	1	1	1	1	1	1
1685067M1	CONE	2	2	2	2	2	2	2	2	2	2	2	2
1686027M91	ASSY GEAR 4TH	1	1	1	1	1	1	1	1	1	1	1	1
1686030M91	ASSY GEAR 3RD	1	1	1	1	1	1	1	1	1	1	1	1
1687640M1	MAINSHAFT 950	0	0	1	1	0	0	0	0	1	0	0	0
1687641M1	MAINSHAFT 950	1	1	0	0	1	1	1	1	0	1	1	1

Potential "Unique Component"

Potential "Common Component"

Several new tractors and major projects have been introduced and the transmission families have met the requirements of these changes with minimal impact on the common module content, while the leadtime to release and structure new units has been significantly reduced.

The success of the restructuring exercise for the transmission families has led to its phased application to all other Transmission Division products. This ongoing expansion has led to the need to develop processes and procedures for dealing with new, or special, assembly requests. This is being handled in the form of a Modular Design Group containing members from engineering, logistics and manufacturing, which can be called together if necessary to discuss and solve a product request that could have an impact on the established modularity. However in the six months that the modules have been in use the group has met only twice, proving perhaps that a latent modularity exists in many products but just needs to be recognised and exploited.

In the longer term all new project introductions are now being examined before their release for their potential modularity and steps are being taken to ensure that the structuring of the new products are in a form that are suitable for forecasting and master scheduling.

CONCLUSIONS

Massey Ferguson have found that bill of material restructuring is possible, practical and rewarding using the 'option sensitive' approach as a guide but applying practicality and common sense to classifying and examining product structures.

However, the true test of the restructuring will be in the way in which the common modules stand up to the demands of the market, ie do they encapsulate the necessary functionality to be stable over time or will they be split and degraded as more exotic products are demanded. The best method of ensuring stability is the inclusion of not only engineering personnel but also manufacturing, logistics and marketing in the definition and maintenance of bill of material structures.

REFERENCES

[1] Garwood D., Bills of Material - Structured For Excellence, Dogwood Publishing Company Inc.

[2] Balcerak K., A Practical Approach to Bill Structuring, Massey Ferguson Presentation 1988.

[3] Balcerak K./Dale B., The Impact of Just In Time on Bill of Material Structuring, BPICS Control Oct/Nov 1986.

[4] Sari J., The MPS and the Bill of Material Go Hand in Hand, Richard C. Ling, Inc 1988.

About the Author

Nick Armstrong has worked in the Logistics field for ten years, the last five at Massey Fergusson Tractors Limited in Coventry where he is Logistics Manager for the Transmission Division. In this position he is responsible for master scheduling, machine shop and assembly planning together with external vendor scheduling.

His area of interest is in the role of the user in Fourth Generation Language applications within Manufacturing. He is a member of BPICS.