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MULTI-LEVEL QUERIES CAN MAKE MS ACCESS A POWERFUL TOOL FOR SMES

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Abstract

This paper demonstrates the power of multi-level queries in MS Access, showing how they may be used to generate an indented Bill of Material without recourse to programming code (such as Visual Basic). The development took place in an SME that specialises in providing ultrasonic solutions to industrial problems. The generating of indented BOMs was one part of a project to provide a costing system for their assembled products.

Keywords: Indented Bill of Material, BOM, product structure, Microsoft Access queries

Introduction

This research arose from a UK government sponsored scheme to place graduates in SMEs for a six-month period with an academic mentor. The scheme was known as “Unlocking Potential” and the authors were respectively the academic mentor and the graduate on one such scheme, with a Company called SRA Developments Ltd.

The objective of the project at SRA was to introduce a costing system, to enable standard and actual cost information to be entered against products and operations. Variances were to be written off as early as possible, and standard costs accumulated for final assemblies. The system was developed in Microsoft Access. Most of this work followed a familiar path and involved little originality of method. However, the Company wished, as part of the project, to produce an indented Bill of Material, to which the standard costs were to be attached. Such a facility is available in standard packages and could have been produced using program code, but this would have produced problems of support and maintenance.

We were able to develop this indented Bill of Material using multi-level queries in MS-Access. Consequently, the skills to support and maintain the system are already available within the company. As this is a novel approach with wide applicability in similarly placed, manufacturing SME's it is our objective in this paper to bring it to the wider attention of the academic community.

Company Background

SRA was formed just over 20 years ago as a consultancy, providing “Ultrasonic Solutions to Industrial Problems”. The company has subsequently developed products that use ultrasonic technology, including Lotus (an Ultrasonic Haemostatic Cutting Instrument), Phys-Assist (a Therapy machine), CDX400 (a Ceramic Tile Cutter) and OSCAR (a Orthosonics System for Cemented Arthroplasty Revision) (<http://www.kellysearch.com/company-77030422.html>).

The project was principally concerned with OSCAR and the company's perceived need to improve its systems for product costing and manufacturing control. However, the methods that were to be developed and proved for that product were expected to be applied for all products within the company. The product had been developed tested and approved and manufacture was already underway.

OSCAR uses ultrasonics to liquefy bone cement that has been used in a previous operation, and can signal to the surgeon immediately if the probe is in contact with bone. In this way, old cement can be removed much more quickly than with traditional methods, without damage to the bone and with correspondingly much less stress on the patient and shorter post-operative recovery periods.

The IT Environment

Though a small company, SRA is scientifically based and well provided with a number of well-qualified scientists and engineers with high levels of IT competence. Even before the project began, a great deal of the information about the products, customers, orders, components, sub-assemblies and suppliers was already being stored and used on a Microsoft Access database. However, it was not clear to them at that stage how the information could be linked through a Bill of Material (BOM) to provide full product costing, that would revise as the costs of components, sub-assemblies and sub-assembly operations were revised.

Alternative Approaches from the Literature

One option would clearly be to implement a manufacturing package that would have all these facilities provided. As Lauden and Lauden (2001) point out, though software packages can provide an economic way of obtaining systems, they rarely provide all that is required and where the software cannot adapt to the user, the user must adapt to the software. With so many useful functions already provided by their Access database, SRA preferred to see whether the BOM linkages could be built within Access, without excessive use of Visual Basic code. They judged that extensive use of Visual Basic could present them with problems in maintenance, and excessive reliance on a few specialists who would know the code concerned. If, however, the function required could be provided in Access with just the use of Tables, Forms and Queries, then Access skill levels within the Company would ensure that there was little need for concern over support issues.

Van Veen and Wortmann (1992) in an article on Generative BOM systems provides computer code for generating an indented Bill of Material from a generic BOM. The use of generic BOMs appeared to offer little advantage to the company, while resorting to computer code would have resulted in significant support and maintenance problems that the company wished to avoid.

Phantom sub assemblies are widely used in manufacturing packages and are strongly recommended by Correll (1995) as a means of flattening Bills of material, thereby reducing Work in Progress and simplifying manufacturing. While this is not featured in the example below, it can easily be provided by adding a phantom (Yes/No) field to the Bill of Material table. While this makes the production of a picking list more complex, it has little impact on SRA's costing system.

Creating the BOM - The Solution

The solution lay in the use of multi-level queries. That is queries based on queries based on queries...etc.

To avoid the technicalities of the product obscuring the explanation, we will illustrate the concepts in this paper using a ball point pen, which we will give the product number B120. Part numbers and product descriptions are more complex at SRA Developments but the table structure used below to illustrate the principle is the same as that used by the company. Let us assume that the ball point pen has the following 5-level indented Bill of Material (see Table 1).

For an explanation of an indented BOM, see Davis et al. (2003). While most introductory books like to show a BOM as a series of linked boxes, as in Slack et al. (2001), real BOMs held on computers are unsuited to this method of display. The number of dots to the left of the part number shows the level of the part number within the BOM. At the first level, the BOM therefore consists of:

- 1 Barrel (part number BA22EL)
- 1 Cap (part number C4P)
- 1 Plug (part number P1UG)
- 1 Refill (part number REF1LL)

This information is easily stored in access as four different records, each of which identifies:

- The part number of the parent part (in this case B120)
- The part number of the child part (in this case respectively BARR1LL, C4P, P1UG AND REF1LL)
- And the number off (the number of that particular child in that particular parent – in this case 1 in each record)

The indented BOM above was, in fact, produced by MS Access from a series of BOM records as illustrated above. Let us look at how this was achieved.

Table 1. Indented BOM for the Example Ball Point Pen

Part Number	Description	Quantity
B120	Ball Point pen	
· BA22EL	Barrel	
· C4P	Cap	
· P1UG	Plug	
· REFILL	Refill	
·· INK	Ink	x 0.027
·· TIP	Tip	
··· B411	Ball	
··· CONE	Cone	
···· ROD	Brass Rod	x 0.6
·· TU8E	Tube	

The Queries to Produce an Indented Bill of Material

The first stage is to examine the structure of the records needed to produce each line of the indented BOM. All these records end with the Part Description and number off for one part in the BOM. The alignment and sort order implies that we need the identity of each parent, grandparent, great grand parent etc. from the part number through to the top level of the BOM. For a five-level BOM this implies a series of records all with the structure:

Parent Part Number

- Child Part Number
- Grandchild Part Number
- Great Grandchild Part Number
- Great Great Grandchild Part Number
- Part Description
- Number off

The record for the Parent part number has its part number under parent part number but all of the other part number fields in the query are null. For each Child part number only the Parent and Child part numbers are filled the other part number fields are blank. A separate query is required for each level of the BOM. Figures 1, 2 and 3 below show the design of these queries for Parent level, the Child and the Great Great Grandchild, respectively. I hope the structure of the other two queries is obvious from these.

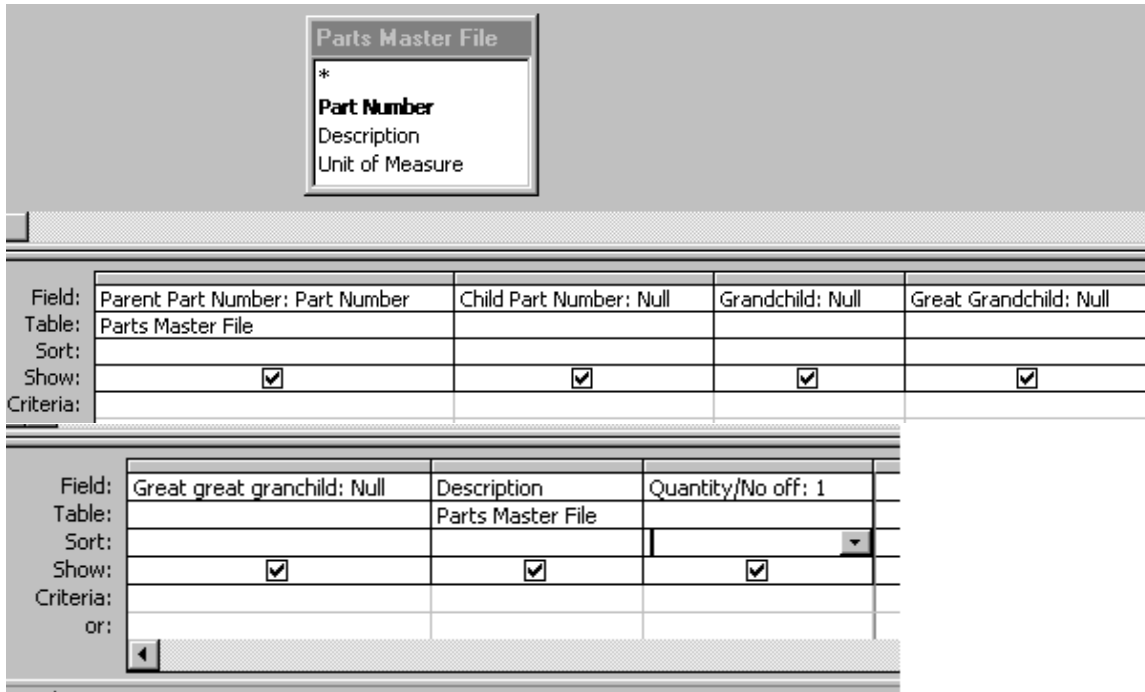


Figure 1. The Query to Identify BOM Records for Parent Parts

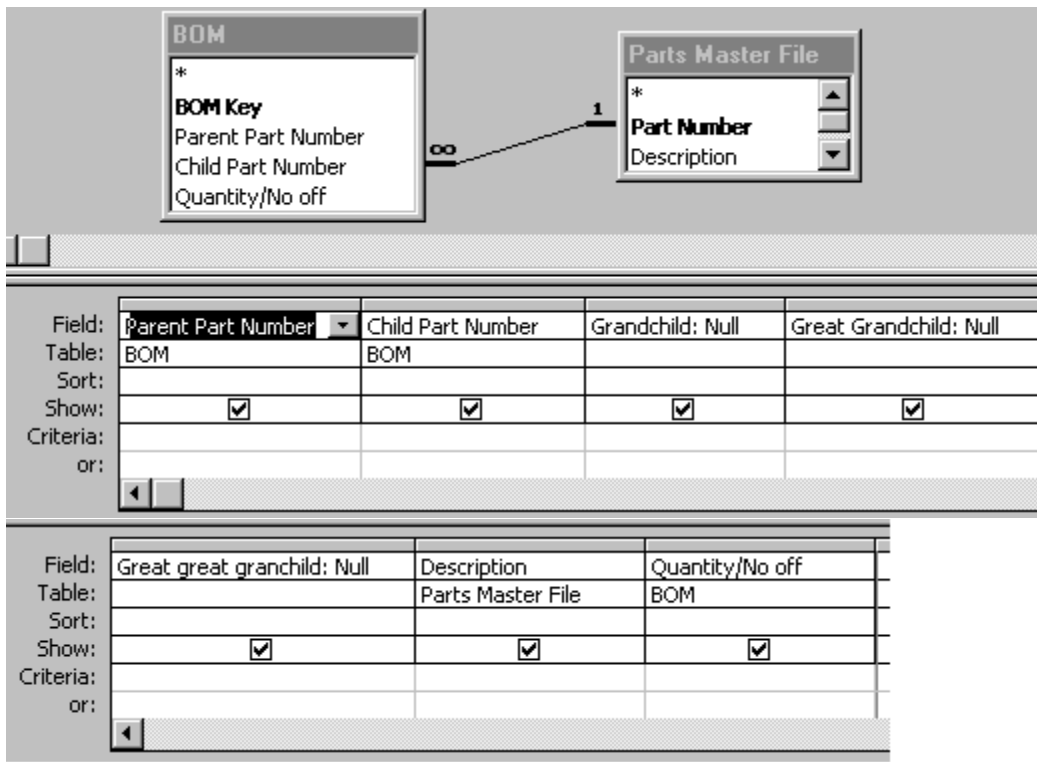


Figure 2. The Query to Identify BOM Records for Child Parts

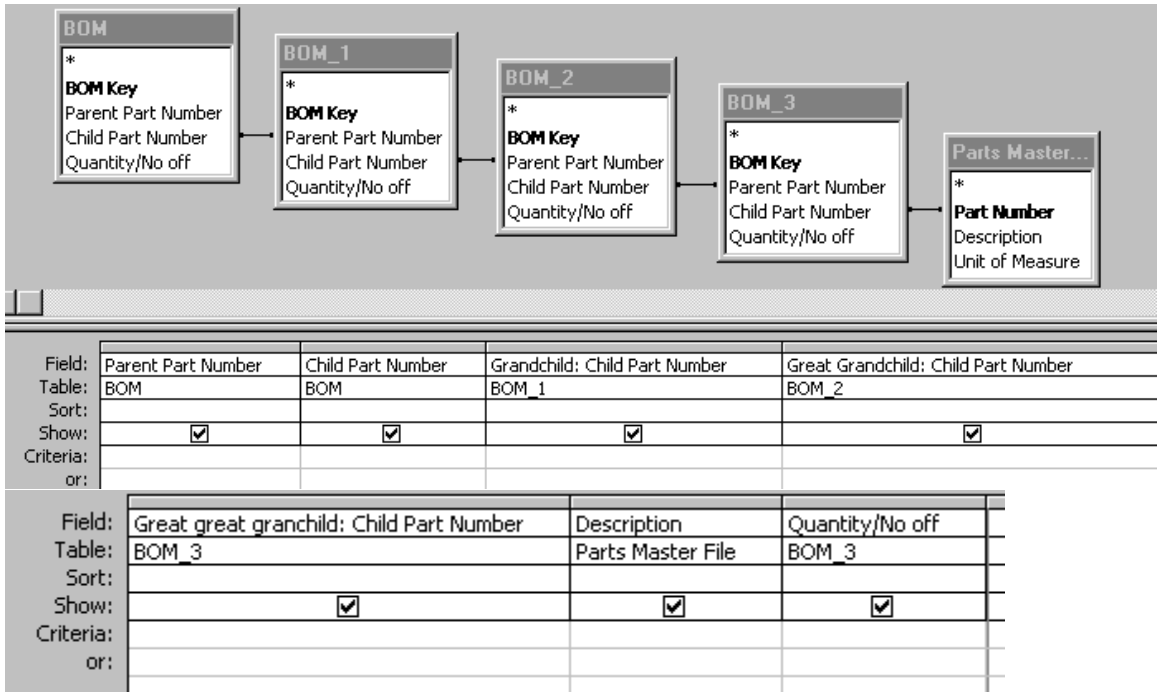


Figure 3. The Query to Identify BOM Records for Great Great Grandchild Parts

The next stage is to create a union Query bring these different records together. The SQL for this query is as follows:

```
Select [Parent Part Number],[Child Part Number],[Grandchild],[Great Grandchild],[Great great granchild],[Description],[Quantity/No off]
```

```
From [Indented__P]
```

```
Union Select [Parent Part Number],[Child Part Number],[Grandchild],[Great Grandchild],[Great great granchild],[Description],[Quantity/No off]
```

```
From [Indented_C]
```

```
Union Select [Parent Part Number],[Child Part Number],[Grandchild],[Great Grandchild],[Great great granchild],[Description],[Quantity/No off]
```

```
From [Indented_GC]
```

```
UNION Select [Parent Part Number],[Child Part Number],[Grandchild],[Great Grandchild],[Great great granchild],[Description],[Quantity/No off]
```

```
From [Indented_GGC]
```

```
UNION Select [Parent Part Number],[Child Part Number],[Grandchild],[Great Grandchild],[Great great granchild],[Description],[Quantity/No off]
```

```
From [Indented_GGGC];
```

From here we need to sort the records in order of Great great grandchild within great grand child within Grandchild within child within parent, and to create the field with the requisite number of dots in front of the part number using the expression:

Part Number: Iif(IsNull([Child Part Number]),[Parent Part Number]," · " & Iif(IsNull([Grandchild]),[Child Part Number]," · " & Iif(IsNull([Great Grandchild]),[Grandchild]," · " & Iif(IsNull([Great great granchild]),[Great Grandchild]," · " & [Great great granchild])))

Notice how a dot is added if the Child part number is not null. Successively as calculation moves to the right, if the part number field is not null an extra dot is added. When a null field is found on the right, or it reaches the end of the part number fields, it adds that part number to the end of the string. The part number of the Parent part is matched to a particular part number on a form to enable the form to display the indented BOM for a particular part. A picture of this query design is shown below in Figure 4. Regrettably, there isn't room to show the full expression for Part Number. A Form with a sub-form based on this query is shown in Figure 5, below.

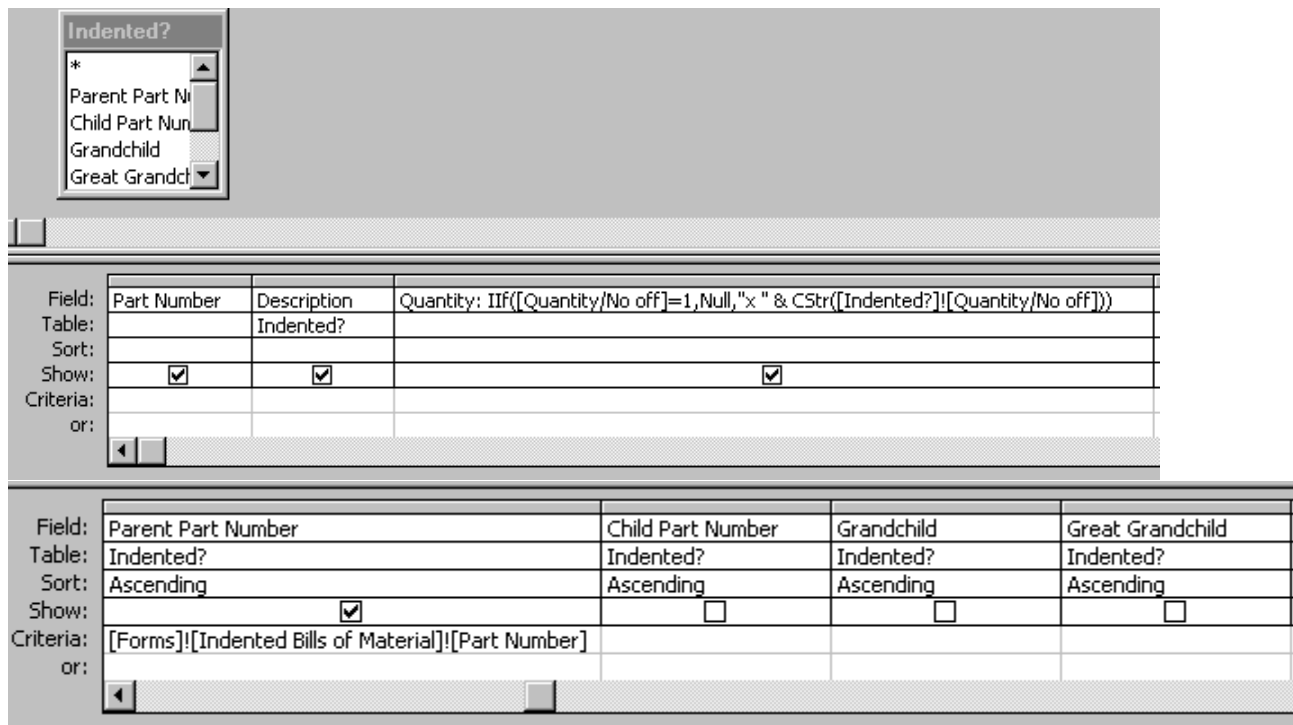


Figure 4. The Query that Ultimately Produces the Indented BOM

Application at SRA

The biro example was introduced in order to make the explanation clearer. The approach was originally developed using data extracted from the Company's database. The version in use at SRA has been developed to accommodate eight levels of BOM, though the principle could be applied to accommodate more levels than that. This was all the company has required so far. It is in use and working well. Not all End Units have yet been added to the database and it looks as if one or two more levels of BOM may need to be added. We don't anticipate a problem in doing this.

The BOM table at SRA is just as simple as that shown above, though their parts master table holds a great deal more information, including standard material cost information.

Links from the part number in the indented BOM through to a routing table also enables costs to be accumulated by operation for labour and machine costs.

The company employs a number of graduate engineers with a good knowledge of Microsoft Access and experience in working with previously developed Access databases. Problems of training and handover were therefore minimal.

Part Number Part Number

Description

Unit of Measure

BOM

Part Number	Description	Quantity
▶ B120	Ball Point pen	
· BA22EL	Barrel	
· C4P	Cap	
· P1UG	Plug	
· REF1LL	Refill	
· · 1NK	Ink	x 0.027
· · T1P	Tip	
· · · B411	Ball	
· · · CONE	Cone	
· · · · ROD	Brass Rod	x 0.6
· · · TUBE	Tube	

Record: of 11

Record: of 11

Figure 5. A Form that Displays the Indented BOM for Each Part

Using a Similar Approach for Product Costing

The costing system developed for SRA dealt with costs in three categories:

- Material Cost (what they pay suppliers)
- Labour Costs (a product of labour hours and labour rate)
- Facilities Cost (a product of time on a machine and a machine hour rate)

The company records both standards and actuals for each of these costs and their constituent elements. In principle, each variance is written off as soon as possible after it occurs, with reasons being investigated where required and standards being continuously updated to the values expected at its next production, given best choice of methods and materials.

The standard cost of material is recorded for each purchased product and the standard material cost of all made-in assemblies is calculated from this when needed using the number off times the material content of purchased components.

Standard labour times and labour categories and standard machine times and work centres are recorded for each operation. Standard labour rates are recorded for each labour category and standard machine hour rates for each work centre. These are then accumulated for each product when needed. These costs in turn are accumulated through the BOM, again multiplying appropriately by number off. An up-to-date standard cost is therefore available for each product when required and the cost changes whenever a constituent cost element or standard production rate changes.

Conclusions

The Company has implemented the new costing system and presents its costs to its management within an indented Bill of Material, using the approach described above. This enables the company's management to focus cost reduction and method improvement efforts more effectively.

As the system that has been developed without using programming code, it can easily be maintained using skills that were already within the company.

The ability in MS Access repeatedly to have queries base on other queries based on still other queries and to use union queries to assemble outputs from different queries with the same format makes MS Access a very powerful tool. It enables work with BOMs and particularly the production of indented BOMs to be accomplished without the need to resort to Visual Basic or any other programming language. This approach had not previously been reported.

For small companies in particular this makes the production of their own systems using Access a viable alternative to manufacturing packages. As well as giving outputs tailored to the company's needs it provides greater flexibility in producing ad hoc queries and reports.

Sharing experience in the development of such systems can be helpful in triggering ideas on how business system needs can be met in novel ways.

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