CONVOLUTION OF THE BOM
OR
HOW MUCH COULD A RESISTOR COST

Permit me a small history lesson from the perspective of an engineer that has been involved with electronic design and manufacturing for over 50 years. I assembled my first electronic project in the fourth grade, and I fabricated my first PCB in Graduate school (circa 1970). Since that date, I have been continuously involved with (and owned) companies designing, fabricating and assembling PCBs.

One of my first projects was a quick turn design and assembly for a company that made caskets. They needed a board with one diode (true story). A quick turn was needed because the end customer was truly “out of time”. The circuit was designed on a quadrille pad (No Schematic capture) and the laid out 2X on a drafting table (No CAD) with Red/Blue tape and Puppets (Remember Puppets?). The part was found in the Allied catalog (Remember paper catalogs?) and, with a quick phone call (Land Line), was put on my account (No Visa or Master Card yet) and mailed Parcel Post (No FedEx). The artwork was taken to the photo lab (No Internet) who reduced the artwork and produced negatives of the artwork (No Gerber). A piece of sensitized laminate was exposed with a sun lamp, developed, and etched in Ammonium persulfate (Ferric Chloride had just been banned). The board was drilled using a manual Electro Mechanical drill (I still have the drill) and the surface was plated with an immersion silver powder. The part was removed from the box (No ERP or Receiving Inspection), formed, and stuffed in the board (No SMT). I grabbed my Kester 63/37 rosin core solder (No RoHS) and my Unger iron. Then, using my teeth as a third hand for the solder, soldered top and bottom (No Tort Lawyers). The assembly was cleaned with alcohol, tested for polarity, and conformal coated with Krylon. Total project time approximately two days. The manufacturer was happy with the quick response. The end customer was cool the whole time and never raised a stink!

With the historical perspective established, let’s evaluate the convolution of the Bill of Material with all of today’s fragmented processes, each with its own (jealously protected) software. For simplicity, change the diode to a resistor and ignore all of the administrative processes required before the project ever reaches engineering (these are an entire discussion in themselves).

The Design Engineer (DE) receives a Project request to design the circuit. DE opens the schematic capture program and designs the circuit. As part of the design process, the BOM is started. In this BOM is entered a 1K, ½ W resistor designated as R1 with a tolerance of 0.5% and 25PPM TC. The circuit is run through a simulator and found to deliver the desired performance. The package is then passed to the Mechanical designer.

Initial BOM columns (Quantity, Description, value, tolerance, Temp coefficient, reference designator)

The Mechanical designer produces 3-D model of the PCB with dimensions in Solidworks that shows a location for a component with dimensions of 120 mils by 60 mils. The package is then passed to the CAD designer.
The CAD designer imports the schematic and the solid model into his CAD Layout Program and then chooses a 1206 package for the resistor to match to size provided in his solid model. CAD designer goes to the web and downloads a .stp file for this package. CAD designer then creates a PCB layout by merging the physical location with the logical part in accordance with the net list. The package is then passed to the Component engineer.

*Additional data columns not in the BOM (Package, XY location, Rotation).*

The Component Engineer (CE) takes the BOM and goes to the standard parts list to assign a physical part to the logical part, R1. CE discovers they do not have a standard part with these characteristics, so a new part must be created in the Part Master of the Manufacturing System Software. The BOM is then sent to the PCB engineer.

*Additional BOM columns (Manufacturer, manufacturer’s part number, and approved alternates).*

The PCB engineer is not familiar with this application, and must hold a meeting to determine which standards are required for a PCB that is to be “entombed”. There is no precedent for this application, so the PCB engineer copies and pastes PCB notes for a “Well Head” application. PCB Engineer then amends the BOM with the description of the PCB and passes the package to Document Control. No additional columns are required.

Document control requests Gerber files from the CAD designer and then assigns part numbers to the reference designators in the BOM. The solid model, the Gerber file and the BOM are now “controlled” in the manufacturing software.

The BOM is sent to the Strategic Ops Manager to determine which of the Global Sourcing Directors are needed to negotiate the pricing for the PCB and the Resistor. Two are needed because PCBs are usually a unique commodity code. The BOM is imported into the Sourcing system (ERP software) which only accepts the attributes of Quantity, Price, Description, Manufacturer, and Manufacturer’s part number, and alternates. The engineering data is often omitted as this is considered superfluous.

Once the price negotiations are complete orders are placed. At which time, document control is instructed to provide the PCB specifications to the winning fabricator.

Following the resolution of all EQ’s, the single resistor and the PCB are received, inspected, and placed into inventory.

The Strategic Ops Manager now directs Global Sourcing to select a Contract Manufacturer with the technical capability to assemble the product. More negotiations occur and a CM is selected. The parts kit is pulled from inventory and shipped to the supplier. The CM receives a copy of the BOM from the ERP system, but (since the kit was provided) much of the purchasing data is not relevant. The data columns needed by the CM are in the original CAD design package which is stored in the customer’s manufacturing system. The CM’s CAM engineer is put in contact with the customer’s document control. It is determined that Document Control has a BOM with Reference Designator, value and tolerance, but does not have the CAD file containing the package, XY location, and Rotation that are needed for programming an SMT machine. These must be procured from design engineering. It is also determined that Document Control does not have the Stencil file from the PCB vendor as this was not requested by
Global Sourcing. The CM now becomes the “integrator” requesting the data they need from each of the groups within the OEM and dealing with the various software packages used by each department. To be successful, the CM must assemble a BOM that has all the columns required to build the product by merging the Design BOM with the CAD BOM with the Manufacturing BOM with the ERP BOM.

This satiric convolution of the BOM is created by the use of specific software systems within each operating department and exacerbated by the absence of a high level integration system that can deal with disparate software systems and their unique extracts. There are all inclusive systems that purport to perform all of these tasks. Without commenting on the efficacy of these systems, I would postulate that getting all operating departments within a company to coalesce around a universal product seems optimistic. Further, a very sage axiom is, “A product trying to be all things to all people relegates itself to being the second best solution to all problems”.

The elegant simplicity of a single engineer managing an entire project is certainly lost in this compartmentalization of the product data. The irony is that an outside resource (The CM) is now required to emulate that simplicity by acting as the “de facto” single engineer.

One could speculate that this seemingly innocent function is one of the major elements fueling the resurgence in Contract Manufacturing in the USA.

Respectfully,

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