BOM Market Report

Status: Draft
Classification: Public
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Date: 15.09.2017-22.11.2017

Objective: Researching the BOM Market for economic production of low volumes in electronic factories

1. Requirements:

For good quality SMD/BGA/THT fabrication, a lot of information is needed for the production process.
It starts with the ERP systems which are used to buy and manage the inventory. Every electronic component / part needs to be registered into the ERP system.
In the ERP system we need the following fields:
- Description
- Product value, Tolerance, ...
- Product code (Mfr P/N), Manufacturer Name / Manufacturer Code
- Stock (per Distributor)
- Estimated/Exepected Delivery Delay
- Product webpage URL (to the manufacturers website)
- Datasheet URL
- Second Source information (optional)
- MOQ (per Distributor and from the manufacturer)
- Information about alternative Order numbers, numbering scheme, … of functionally identical products of the same manufacturer („this is the same product, it is just packaged differently")

Then comes the solder dispension and Pick&Place machine. They need need the following information:
- Form of the part (JEDEC code, ...)
- Packaging type (Reel, Tray, Bag, ...)
- Reel-Width in millimeters (e.g. 5,12,14,16 mm)
- Orientation of the part on the Reel (0°, 90°, 180°, 270°)
- Height of the part in millimeters, so that the Pick&Place machine knows where to start sucking, and does not crash into the product
- Dispense-pattern (this is a vector graphic which shows where the solder-paste is dispensed for each part. The pattern is similar to the footprints in the PCB-Design, but different
- Special Solder-Paste amounts

At the end comes the optical inspection (AOI). Unfortunately, the data needed there is currently too much PCB-dependent, therefore it does not make sense to supply it.

For all systems we need warnings:
- Lifecycle warnings
  - End of Life

- ○ Last Time Buy
- Environmental warning
  - ○ RoHS/Reach
- SupplyChain Warning
  - ○ No Second Source
  - ○ Only one Exclusive Distributor
- Security Warning
  - ○ Product does not provide the originally intended security
    - ▪ with a link to the CVE and relevant papers
  - ○ Product is often applied in an insecure way
- Storage Warning
  - ○ special temperature requirements for storage
- Pick&Place Warning
  - ○ special mounting tools required („Bestückhilfen")
  - ○ special feeders are required
  - ○ special vacuum needles are required
- Soldering Warning
  - ○ Heat-sensitive – special temperature curve is needed

While we are trying to solve the low-volume production efficiency, we also try to improve the security.

2. BOM Importers

IHS - BOM Intelligence

We started with the seemingly largest database from IHS Markit, Canada.

They claim to have over 500 million parts, but unfortunately identical components that are differently packaged are counted multiple times, so the number of unique components is most likely much lower. Another topic about the counting the parts are historical products, IHS also has a nice archive of old products, which is an advantage, but also makes counting and comparing different databases more difficult.

IHS provides:

- A huge, well-curated database with information about parts

- BOM Intelligence, a web-based tool to import BOMs, match BOMs against the IHS database and subscribe to alerts for those parts

- An API to access the database

- I also heard about BOM Manager, but I haven't seen that tool yet, I am not sure whether it would be any help for us.

It does not seem to provide the functionality to match BOM's against inventory part lists yet. (But you can upload your inventory list as a BOM)

Problems in the BOM Intelligence tool:

- Scrollbar

In one of the matching views, there is a slider at the right bottom, that could not be moved due to an overlapping with other GUI elements. I experienced the bug myself, and a few days later it also happened to presenter of IHS during a Webinar. Small bug, should be easily fixable in the next version of BOM intelligence. **Workaround**: Try to click in the upper part of the scrollbar and in the lower part of the scroll bar and above and below of the scrollbar. You might find a spot where you can drage the scrollbar. Alternatively try the scroll-wheel on your mouse. Alternatively try another browser.

- BOM Import of CSV files

BOM Import currently cannot cope with CSV files that are comma (,) seperated, it expects semicolons (;). One example PCB Design tool I found that generates such files is KiCad. **Workaround:** Load the CSV files into Excel with the „Data"→"From Text" function or into LibreOffice Calc, then export them to .xls or .xlsx format, then load those files into BOM Intelligence.

- BOM Import of OpenDocument Spreadsheets

BOM Import currently does not support OpenDocument format at all. **Workaround:** Load the .ods into LibreOffice Calc, then export them to .xls or .xlsx format, then load those files into BOM Intelligence.

- Session Timeouts

There are considerable session timeouts of about 10 minutes.

Workaround: Save your work often!

- Parts security issues

BOM Intelligence does not inform you in any way about insecure components. It does not provide any security documents, does not provide any security alerts, so you have to do your own security research to avoid insecure parts in your BOM! From my point of view showing green lights for the LifeCycle of a part that has material security issues is negligent and advertising insecure products. It is surprising that IHS Markit provides „Cybersecurity package"
https://www.ihs.com/products/cybersecurity-package.html but seems to ignore the security of the

underlying hardware products and does not alert producers to use known insecure components in their products.

Workaround: Do you own security research!

- DNP – Do not populate

Several of the BOMs I tried had „(DNP)" notices in them, which indicated that this part should not be populated, so it can be ignored from BOM. BOM Intelligence has no mechanism to deal with that directly. There is a somewhat similar functionality, the „Preferred Y/N" field, which is made for defining preferred and alternative parts in different lines of the BOM, but it has to be in it's own field, and the (DNP) is usually added at the end of the description field. Since BOM intelligence does not display the whole field, the (DNP) notice might get cut off at the end of the comment field, so it's a bit harder to find and notice the DNP. Perferrably, BOM Intelligence should notice (DNP) notices in the comment fields and handle them. Perhaps by asking the used, whether they should be all deleted/ignored, to avoid wasting time matching parts that aren't needed.

Workaround: Search for (DNP) and delete the records in the original BOM file before you upload it, if you do not want to match them.

- Manufacturer Mergers

When matching manufacturer names, BOM intelligence does not always directly inform you about mergers and name changes that happened in the past, better explanations like „NXP was seperated from Philips in 2006", „Freescale was bought by NXP in 2015" would be helpful for the matching process. **Workaround**: Search for the manufacturers on Google

- Manufacturer Matching

When you match a manufacturer, BOM intelligence does not display you the product numbers that it wants to match for that manufacturer, and whether any of the offered manufacturers are producing products with the needed product numbers (or products whose names start with the needed product numbers). **Workaround**: When you get several different manufacturers offered, and you are not sure, which one it could be, check yourself whether the suggested manufacturers match with the product codes that are needed.

- Import errors

If a BOM has an additional header line, and the field names start in the second line, you can define that BOM intelligence should start reading in the second line but later on BOM intelligence gives error messages like these:
Error 1: [Line 3] The "Imported Mfr P/N" value is empty.
But that field is not empty. This is a bug.

Workaround: Delete any rows at the top, so that the field names are in the topmost row.

- Alternative parts

When you search for an alternative part, you sometimes have part variants that are very similar, and it is hard to find out, what the actual differences are. BOM intelligence should provide an option to sort the columns and first show those columns where there are differences between the different products, and then show the columns where all products are equal. **Workaround**: Buy a larger monitor so that you can see more rows and columns at the same time or scroll around to find the differences.

- Checking back with the Designer

When you are not the designer and you get several possible matches for a requested part, or you are searching for alternative parts and you find several different possible matches, you might have ask the original designer (or some other engineer), whether the suggested parts actually fulfill the design-requirements, or which of them should be preferred. Currently there seems to be no mechanism in BOM Intelligence to handle that. **Workaround**: If the designer is geographically available, fetch the designer out of any important meeting and work with him together on the same computer. If he is too far away: Generate a report (XLS or PDF), send the report to the designer asking for preference or approval. Hope that the report contains everything necessary, and that the designer does not need additional information and that you do not waste too much time collecting it.

- Documenting decisions and open questions

When you have to match parts, and you aren't absolutely sure whether the match is really the right one, BOM Intelligence does not give the option to add a comment on your match that you might want to revisit the match. If you choose a specific part, it might be useful to document the reason why you chose that part and not the others, so that other BOM managers can learn from your decisions, and that you know later on why you did the decision that way. **Workaround**: Write your own documentation about it elsewhere

SiliconExpert

SiliconExpert provides a similar parts database and data quality to IHS Markit. The Part Search looks good and provides better usability, I haven't had the opportunity to test the BOM Manager yet.

MacroFAB

https://macrofab.com/help/creating-managing-ordering-pcbs/managing-pcb-bill-materials/

Technical Interoperability

The technical interoperability on the BOM market was evaluated.

The results are shared online, so that additional results can be added later in the future:

https://docs.google.com/spreadsheets/d/1JqG4_1DkVpevZ9IidSzXqEIuSBzyk9srWTim-fyydQI/edit?usp=sharing

Design Intent - Interoperability

What is Design Intent?

Component Type: Resistor
Component Value: 220ohm, 1W, 20% tolerance
Footprint: 2512

What is a buyable part?

Manufacturer: KAO Speer
Manufacturer P/N: SG733ATTE221M

Both are referencing exactly the same thing.

From the interoperability study, it seems that PCB Design Tools prefer to provide Design-Intent in the generated BOMs.

What should be written in a BOM? Design-Intent, Buyable Parts or both?

Option 1: Design-Intent

If the BOM only contains Design-Intent, it's hard to find buyable parts for it and actually buy them, and to know whether those parts are really fulfilling the requirements of the design. Most of the BOM consuming tools are not able to handle Design-Intent, so they cannot work with BOMs that only contain Design-Intent. BOMs that only contain Design-Intent have a higher risk that buyers will buy the wrong parts. (Does anyone have research data on this problem?)

Option 2: Buyable parts

If the BOM only contains buyable parts, it's hard to decide on replacement parts when the original parts are end-of-life or otherwise unavailable, or other cheaper parts would be available.

Example usecase: A resistor is needed with 20% tolerance. The designer has 10% tolerance parts available when the product is designed, so he enters a product number the specifies 10% tolerance. The BOM only states the product number with 10% tolerance. A year later, the factory runs out of 10% tolerance parts, but still would have 5% tolerance parts and 20% tolerance parts available. Since the BOM specifies 10%, they opt for the 5% tolerance parts instead of the 20% tolerance parts, resulting in a far more expensive production run than would have been necessary. If the BOM

had stated both Buyable parts and Design-Intent, they could have chosen the 20% tolerance parts, and saved money that way.

Option 3: Design-Intent and buyable parts

Some design tools do not have enough attributes to define both Design-Intent and buyable parts.

The current BOM market does not seem to address Design Intent properly

BOM Generators

KiCad

KiCad interestingly has 2 different BOM generators. One of them is in PCBnew (the PCB design tool), which generates BOMs in a fixed CSV format with ; a seperator. Unfortunately this fileformat isn't widely accepted by the BOM importers. https://bugs.launchpad.net/kicad/+bug/1717721

The other one (and lately more maintained) is in the schematic editor, which can be configured with individual templates, and even python scripts that can generate arbitrary fileformats. Here KiCad exports all relevant information into an XML file, which is then handed over to the plugin, either XSLT or Python. Depending on the Plugin, CSV, HTML, … are possible output formats, and you can adapt it to your own needs.

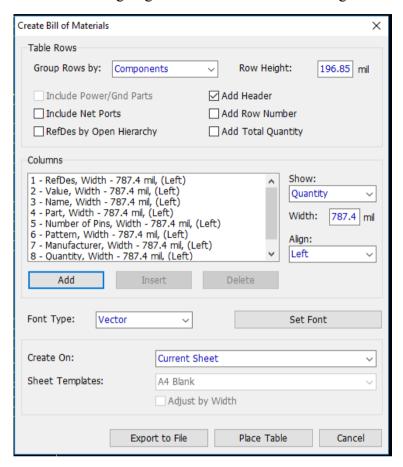## Fritzing

Fritzing can currently only export BOMs in .HTML format, which cannot be read by any other tools.

http://forum.fritzing.org/t/bom-interoperability-study/4509

DipTrace

This is the dialog to generate a BOM from the design.

It has several possibilities of grouping the rows: "Components", "Parts", "Component Name", "Name and Value".

"Parts" are sub-components - e.g. separate gates in a 74-series chip.

Altium Designer

Configuring the BOM :

http://www.altium.com/documentation/17.1/display/ADES/PcbDrawing_Dlg-BillOfMaterialsConfigurations((Bill+Of+Materials+Configurations))_AD

Template Management for BOMs:

http://www.altium.com/documentation/17.1/display/ADES/((Managed+BOM+Templates+in+an+Altium+Vault))_AD

Suggested Readings:

How to make a BOM: https://www.bunniestudios.com/blog/?p=2776

https://www.aligni.com/doc/

http://docs.kicad-pcb.org/stable/en/eeschema.html#creating-customized-netlists-and-bom-files

http://server.ibfriedrich.com/wiki/ibfwikien/index.php?title=Bill_of_Material_BOM

Electronic Production Process

(only relevant parts from the BOM point of view, in pratice the process is more complex)

Design Tool vendor

Developer

Design-Tool
KiCad, Altium Designer
...

Designer

Symbol
Footprint
Datasheet
STEP 3D-Model

Raw Materials

Semiconductors

Samples

Components

Design
Files
Schematic
PCB

BOM

Distributor

Gerber

Pick&Place File

Order

Reels, Trays, …

PCB Factory

PCB

Electronic Factory

Purchasing
ERP

Warehouse
(no Just-In-Time)

Pick&Place

Optical Inspection

Final Product