A small electronics company's response to new environmental legislation affecting the production of electrical and electronic equipment

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Abstract

With new European environmental legislation affecting the production of electrical and electronics equipment being introduction between August 2005 and July 2006, Geoff Bullen Electronics (GBE) has had to assess the impact this will have on their contract electronic manufacturing aspect of the business. One of the legislation to be introduced will require the elimination of several hazardous substances from all components and processes. Lead, one of the hazardous substances, is wide used as an ingredient of solder, the glue of an electronic circuit. This requires an audit of all inventory to ensure the exhaustion of leaded parts before enforcement begins. This process is made more difficult the UK Governments delay in implementing the requirements of the legislation. GBE has found it challenging to balance the need to work towards ensuring compliance and commitments to current production and design obligations.

1. Introduction

It is Thursday morning, as I make the journey to work I notice the rows of upturned blue boxes on the kerbside. Turning the corner I am presented with a large lorry blocking most of the street; collection day. We all grumble about having two bins, and having to rinse out that empty baked bean tin, just to throw it away, but when existing landfill sites in West Sussex will be full up within 5 years alternative options have to be taken more seriously.

These recycling initiatives are the result of the European Union's strategy for waste management. The Commission Communication of 30 July 1996 on review of the Community strategy for waste management [1] states that, where the generation of waste cannot be avoided, it should be reused or recovered for its material or energy. This has resulted in legislation to tackle the rapidly growing waste arising from electrical and electronic equipment. UK households throw away about a million tons of electrical and electronic equipment in a year.

2. The WEEE Directive

Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) [2] will shift the responsibility for recycling from the consumer to the producer. Producers will be responsible for taking back unwanted equipment then either reusing or recycling it accordingly. By making the producer responsible for equipment at end of life, the Directive will provide an incentive to design the equipment with more consideration to disposal.

The Directive separates WEEE into 10 categories, any equipment that fall outside of these categories are considered as exempt. Other exemptions from the directive exist, however these are not discussed in this paper.

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers

2.1 UK Government Delays Implementation

Article 17 of the directive requires Member States to bring into force the laws, regulations and

administrative provisions necessary to comply with this Directive by 13 August 2005. In the UK this has resulted in the Waste Electrical and Electronic Equipment (Producer Responsibility) Regulations 2004 [3].

On 10 August 2005 the Government made an announcement on the timetable and policy leading to implementation of the WEEE Directive in the UK [4]. This announcement stated the Governments intention to implement the WEEE Directive's producer responsibility and retailer take-back obligations in respect to WEEE in June 2006. Until more details are published the impact of the WEEE Directive cannot be fully understood.

The announcement also stated that the Government will implement the WEEE Directive's requirements to mark electrical and electronic equipment, to facilitate its separate collection from other forms of waste, from the entry into force of the WEEE Regulations.

2.2 Product Marking

A requirement of the WEEE Directive is to mark equipment with a crossed out wheeled bin symbol to indicate the equipment falls within the scope of the Directive. BS EN 50419:2005 [5] details the proposed implementation of the marking detailed by the WEEE Directive shown in Figure 1. The solid black bar is used to signify the equipment was put on the market after 13 August 2005. The directive also states that producer of the equipment also be clearly stated.

Figure 1: WEEE Compliance Product Marking.

3. The RoHS Directive

The recycling of electrical and electronic equipment presents its own challenges; a lot of WEEE contains toxic materials. To combat this Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS) [6] will come into force on 1 July 2006. The directive will ban the placing on the market of new electrical and electronic equipment containing more than the maximum concentration of 6 hazardous substances, shown in Table 1. As with the WEEE Directive, exemptions from the directive exist, these are also not discussed in this paper.

Substance	Maximum Concentration Values (by weight in homogeneous material)
Lead	0.1%
Cadmium	0.01%
Mercury	0.1%
Hexavalent chromium	0.1%
Polybrominated biphenyl (PBB)	0.1%
Polybrominated diphenyl ether (PBDE)	0.1%

Table 1: Substances restricted by RoHS Directive

3.1 Lead-Free Soldering

Lead containing solder has been used in the manufacturing of electrical and electronic equipment for decades. The RoHS Directive will force the industry to change to a lead-free manufacturing process. This has raised concerns; material availability, cost, manufacturability, and reliability. Although these are genuine concerns, most could be attributed to a resistance to change.

4 Geoff Bullen Electronics

Geoff Bullen Electronics (GBE) is a small electronics company based in Lancing, West Sussex. The family owned business, which began as an electronic component distribution company in March 1988, today offers electronic manufacturing, obsolete component distribution, component sourcing and kitting and electronic product design.

During 2004, GBE was first introduced to the WEEE and RoHS Directives by an advisor for Envirowise. This was followed up with attendance at the Southern Electrical & Electronic Directives Show (SEEDS) 2004. Although GBE released early on that WEEE and RoHS was a priority, company commitments meant that preparation towards compliance could not begin for another year. The addition of another member of staff to GBE, as part of a Knowledge Transfer Programme with the University of Brighton, allowed resources to be allocated to the investigation of the Directives.

2005, has been a RoHS watershed, with the majority of electronic manufacturers and distributors publishing material on their compliance roadmaps. The summer period has seen numerous distributors holding information seminars. Attendance at a selection of these seminars has given GBE an

understanding of the schemes distributors are using to communicate compliance information.

4.1 Business-to-Business WEEE

The majority of GBE's clients are other businesses and not the consumer market; this effects the company's obligations to the WEEE Directive. GBE has taken the decision to wait until the final guidance is published before interpreting its obligations. Exactly how the WEEE Directive obligations will propagate up the supply chain is unclear.

4.2 Preparations for RoHS Directive

The WEEE and RoHS Directives will affect all aspects of GBE's business. Initial investigations into the RoHS Directive are focused on electronic manufacturing. This has investigation has begun with GBE's largest order, both in terms of cost and volume, the Rickshaw project.

5. Rickshaw Project Case Study

5.1 Overview

The Rickshaw project is a mobile data unit, designed for our client by a third party design consultancy. GBE has been the manufacturing partner for the client's other electronic hardware solutions for the passed 12 years and successfully secured the manufacturing contract for the Rickshaw project.

The data unit uses an Intel® XScale™ microprocessor core, implemented in a wide variety of personal digital assistants (PDAs) and other mobile devices, to run the Microsoft® Windows® CE .NET 4.2 operating system on which the client can execute their application software.

Manufacturing the Rickshaw project is considerably different from other projects undertaken by GBE. The bill of materials (BoM) contains approximately 230 line items, by 50 manufacturers, from over 25 different suppliers. The majority of the electronic components declared in the BoM are surface mount devices, shown in Figure 2. GBE sub-contracts surface mount volume production to a Hampshire based company, with pick and place and Ball Grid Array manufacturing facilities.

Figure 2: Surface mount components.

As the manufacturing partner, GBE is responsible for all stages of the manufacturing process, from the sourcing of the materials and components that are declared in the BoM, through to the despatch of the units to the client's customers., Figure 3 outlines the process. The responsibility for sourcing and purchasing the parts for the project also brings an obligation to ensure that the project will be compliant with the RoHS directive when it comes into force on 1 July 2006, although ultimate responsibility lies with the client (as they are placing the device on the market). GBE does not wish to be in a situation where it holds inventory after the 1 July 2006 deadline that it cannot invoice for as it is not compliant with the RoHS directive.

5.2 Beta Testing

GBE has been involved with the Rickshaw project since the hardware was released by the design consultancy for production testing. During the last quarter of 2004, a batch of 100 units where manufactured for pre-production testing, which highlighted a number of hardware and software issues. These were addressed by members of GBE's design team instead of the design consultancy. These issues resulted in significant delays in the release of the project for volume production of the unit and further investigation into the RoHS compliance status of the project.

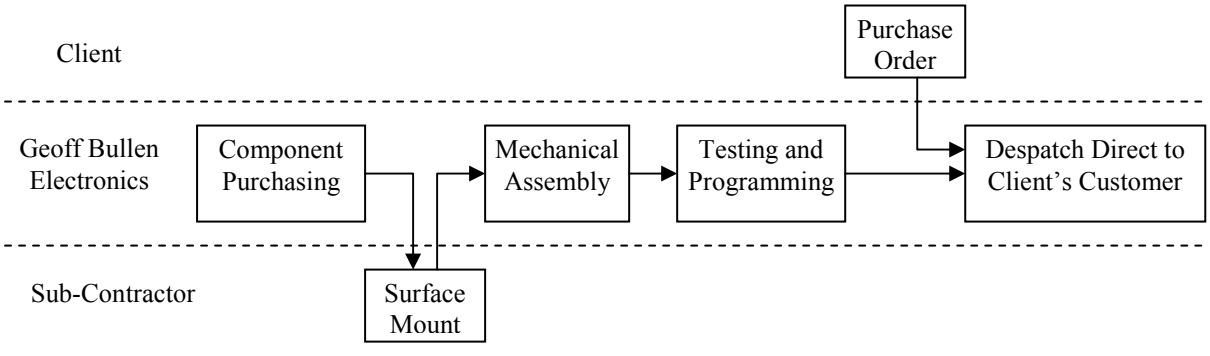

Figure 3: Outline of the Rickshaw manufacture process

It was not until July 2005 that a further batch of 120, production quality, units where manufactured to allow the client to perform field testing their application software. This delay has allowed GBE to gain a greater understanding of the project and to prepare for volume production.

5.3 Documentation

Internal supporting documentation for this project has not quite reached sign-off stage, in accordance with GBE's ISO9001:2000 Quality Manual, this is primarily due to the delays and subsequent in-house redesign work mentioned above. The benefit of this is that requirements for assessment of compliance with both the WEEE and RoHS directives can be incorporated, forming a blueprint for other projects.

GBE maintains and schedules stock on a per order basis. The Rickshaw project was assigned an order reference number for an initial order for 5,000 units. An active order spreadsheet was created containing the BoM compiled from documentation produced by the design consultancy. An advantage of having the BoM tied to the order number is that traceability is built into the process. Providing that the current order can be satisfied before the compliance deadline for the RoHS directive, non-compliant stock can then be eliminated during the sourcing process of parts for the next order. Any alterations to the BoM will be signed off by GBE and their client.

On initial investigation of the Rickshaw project active order, for WEEE and RoHS compliance, it was identified that electronic components are well documented, but mechanical parts are not; for example screws and packaging. To ensure compliance to the directives can be achieved all parts must be documented.

6. Steps to Determine Compliance Status

6.1 Bill of Materials

To determine the current status of the Rickshaw project, the BoM needed to be separated into the production assembly steps, outlined in Figure 3. Once this is achieved all the parts for any given step can be investigated and recorded. Prior to this the BoM went from individual parts to complete product. Now the BoM is much more logical to follow and missing parts can be easily identified. By assigning internal part numbers to each of the assembly stages the work in progress can be easily measured, a process not originally available at GBE.

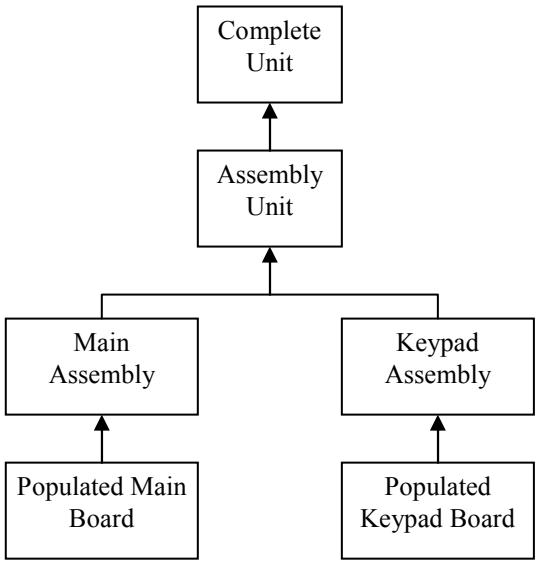

Figure 3: Outline of production assembly steps.

6.2 Part Number Conformation

Once a completed BoM has been established the process of determining the status of every part can begin. A painstaking audit of purchase orders, delivery notes and supplier invoices for the project had to be performed to ensure that the manufacturer details and part numbers matched the information in the active order spreadsheet.

As there is not common approach to declaring information on RoHS compliance, the audit allowed GBE to identify if a supplier has implemented a declaration scheme at the time a part was received, an example is shown in Figure 4.

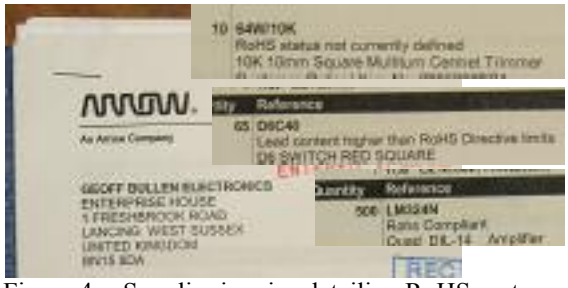

Figure 4: Supplier invoice detailing RoHS part status.

6.3 Manufacturer Declaration

With the audit completed the trail is then followed back to the manufacturer. The datasheet for each part is then investigated to determine the RoHS status of the parts purchased. Each part can fall into one of five categories, detailed in Table 2.

At the time of compilation of this paper, GBE was currently at this stage of working through the BoM to determine the current compliance status of the

Rickshaw project. Currently, no part has been identified as not being RoHS compliant with no alternative available. Table 3 includes an examples observed.

RoHS Status	Further Information
Is already RoHS compliant	
Is not RoHS compliant	Alternative part number for RoHS compliant part
	No part number change, RoHS compliant after date
	No RoHS compliant alternative available.
No information currently available	

Table 2: Categories for individual part RoHS status.

Panasonic Aluminium Electrolytic Capacitor	
Current Part Number	ECEV0JA470SR
Current RoHS Status	Not RoHS compliant
RoHS Compliant Part	Alternative Part Number EEEV0JA470SR
Fairchild Hex Inverter	
Current Part Number	74LCX14MTC
Current RoHS Status	Not RoHS compliant
RoHS Compliant Part	Compliant from July 2005, date code 0530
Wurth WE-PD Power Choke	
Current Part Number	744 777 20
Current RoHS Status	Already RoHS compliant

Table 3: Examples of part RoHS status.

6.4 Forecasting RoHS Compliant Bill of Materials

GBE cannot reliably progress with this stage until the project is released to production. Once volume production has begun the consumption of stock can be forecast. Provided any part that is not RoHS compliant is depleted prior to 1 July 2006 then no action need be taken. If this is not the case then a course of action will need to be considered accordingly.

6.5 Quarantine of Stock

It is feasible that GBE could hold inventory of some compliant and non-compliant parts. On these occasions it is important to be able to differentiate between these and ensure that the non-compliant inventory is used before the compliant inventory.

Once the status of the current stock has been identified, during the transition period, the parts will be labelled to allow easy identification. After consultation with our surface mount sub-contractor and various supplier presentations, GBE is planning to adopt the following labelling strategy shown in Figure 5.

7. Lead Free Soldering Process

The final stage of securing RoHS compliance is to migrate to a lead free soldering process. This stage cannot occur until all the electronic components are confirmed as being lead free. This is because no lead can be present during the lead free soldering process; any lead could compromise the integrity of the solder joints.

A small lead free batch will need to be produced in advance of the deadline to ensure the functionality of the unit is preserved. Environmental tests may also need to be repeated to ensure that the performance is not affected. These tests will require discussions with the client to agree a test strategy.

After discussions with the surface mount sub-contractor it was agreed that, as GBE free issue all stock to them, they will only certify their surface mount manufacturing process as being RoHS compliant. The compliance of the individual parts will rest with GBE.

8. Identification of Lead Free Product

Once a lead free product is achieved a method of declaring this is required. This is likely to take the form a certification document produced by GBE detailing the methods taken to achieve the status. As this is a legally binding document it will need to

Figure 5: GBE identification labels for part status.

be thoroughly discussed before creation.

As to the physical identification of the lead free product it has been suggested that the colour of the printed circuit board be changed. This will ease identification by personnel servicing or repairing the unit, to prevent any contamination from the use of leaded solder.

9. Conclusions

With knowledge of the WEEE and RoHS Directives growing every day it is clear that GBE has not underestimated the task of ensuring compliance and appreciates that this is not a trivial task. By allocating resources to the task at the early stage GBE are confident it will still be able to meet the task of achieving compliance prior to the RoHS Directive enforcement date of 1 July 2006.

The investigation has been limited to a single product and client. This will have to be extended to cover all electronic manufacturing.

The impact on the other areas of the business has still to be investigated. It is, however, anticipated that the knowledge gained within manufacturing can be easily transposed to other areas.

The UK Government delay in implementation of the WEEE Regulations has affected the approach GBE has taken. Once more guidance is published GBE will seek to distribute the information to its clients quickly.

With the introduction of the requirements to mark products for the WEEE Directive during August 2005, GBE has kept all of it clients fully informed of the necessary labelling. GBE will use their knowledge of the WEEE and RoHS Directives to help ensure all their clients are able to meet their individual obligations to the Directives. GBE also sees this knowledge as a resource it can offer to prospective clients, to complement their experience of the Electromagnetic compatibility (EMC) Directives.

References

[1] Commission Communication COM(96) 399 final of 30.07.1996: “Communication from the Commission on the review of the Community Strategy for Waste Management”.

[2] Official Journal of the European Union, L 37, 13.02.2003, p24-38, http://www.dti.gov.uk/sustainability/pdfs/finalweee.pdf

[3] DTI Consolation Paper on WEEE and RoHS, 30. 07.04, Part II “The WEEE Directive – draft implementing regulations”, http://www.dti.gov.uk/sustainability/weee/WEERegulations_draft.pdf

[4] C Talloy, 10.08.05, “Implementation of the EU Directive on Waste Electrical and Electronic Equipment (the WEEE Directive)”, http://www.dti.gov.uk/sustainability/weee/WEE_e_letter_August2005.pdf

[5] BS EN 50419:2005, “Marking of electrical and electronic equipment in accordance with Article 11(2) of Directive 2002/96/EC (WEEE)”, BSI

[6] Official Journal of the European Union, L 37, 13.02.2003, p19-23, http://www.dti.gov.uk/sustainability/pdfs/finalrohs.pdf

Author Biography

Mark Bewley joined Geoff Bullen Electronics on 31 January 2005 as the KTP Associate for the Knowledge Transfer Partnership with the University of Brighton. Mark graduate from the University of Bradford in July 2004 with Bachelor of Engineering (Honours) in Electronics, Telecommunications and Computer Engineering. As part of the two year KTP project to equip the company with the capability to design software and embedded microelectronic systems, Mark fulfils the role of Product Development Engineer.