



Towards intelligent recycling: a proposal to link bar codes to recycling information

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Abstract

A system is developed that links existing bar codes on mobile phones to web sites containing disassembly information. By reading a bar code, the recycler can determine the exact make and model of the product and automatically be shown correct dismantlement information.

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1. Information technology and recycling

Information technology has become ubiquitous in the manufacturing and retail sectors. Virtually every product is labeled with a bar code, and the production, distribution, and sale of every item is tracked by computer databases.

But the recycling and waste management industries still operate the old fashioned way. There is occasional use of bars codes, and occasional use of databases to track individual products as they are recycled. But the end-of-life management of products has seen nothing like the “information revolution” that has become integrated into product manufacture and sales.

The adoption of information technology has made production, distribution, and retailing of products more efficient and less expensive. We expect that information technology could also make product end-of-life management more efficient and less expensive (Saar and Thomas, 2003). However, the fact that recycling has more or less failed to adopt information

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technology indicates that there are significant barriers to be overcome. Recyclers typically have little control over the products they receive. The products that recyclers do receive are typically old and from a wide range of manufacturers. Moreover, recycling operations typically must keep costs to an absolute minimum, so they have little capacity to experiment with new technology.

In this communication, we propose an application of information technology to recycling that would be inexpensive and easy to implement. This application could help product manufacturers and recyclers to begin to develop other applications of information technology for recycling, repair, reuse, and disposal.

2. The information challenge of cell phone recycling in the European Union

The European Union's "Waste from Electrical and Electronic Equipment Directive" (WEEE) aims to increase recovery and recycling rates for electronic products, thus minimizing the environmental impact of electronic equipment at end of life (Boks et al., 2000; Commission of the European Communities, 2000; McLaren et al., 1999). WEEE came into force in the European Union countries in February 2003 and is to become law in the member countries by August 2004, with the full producer responsibility provisions expected to come into force in August 2005.

Among other provisions, WEEE requires manufacturers of electrical and electronic equipment to provide information to recyclers and dismantlers on the dismantlement of products, and on the location of dangerous substances. Producers must also provide manuals for maintenance, re-use, upgrade and refurbishment.

To fulfill the requirements for a broad range of information on their products, manufacturers of electrical and electronic equipment must address two problems at the same time. They need to gather and develop the necessary information on products, and they need to provide the information to recycling and dismantlement facilities.

There are many different models of each type of electrical and electronic equipment, and each model may have different components and different requirements for dismantlement and recycling. There are, for example, over 1800 different models of cell phones registered with the European Telecommunication Standards Institute, made by more than 50 manufacturers (Nobbi, 2003).

Providing dismantlement information for each product to all dismantlers and recyclers in the traditional way, using manuals for disassembly printed on paper, would require significant amounts of paper and an ingenious system for delivering the manuals to every dismantling and recycling facility within Europe (and for finding a particular manual when it is needed). Even establishing a web-based information system would not completely solve the problem, because it is often difficult to identify the specific model of a product just by looking at it.

3. Using the bar codes that are already on products

To address this problem, we have developed a demonstration system which links the existing bar codes on products to web sites containing disassembly information. The proposed system is summarized in Fig. 1. By reading a bar code, the recycler can determine the ex-

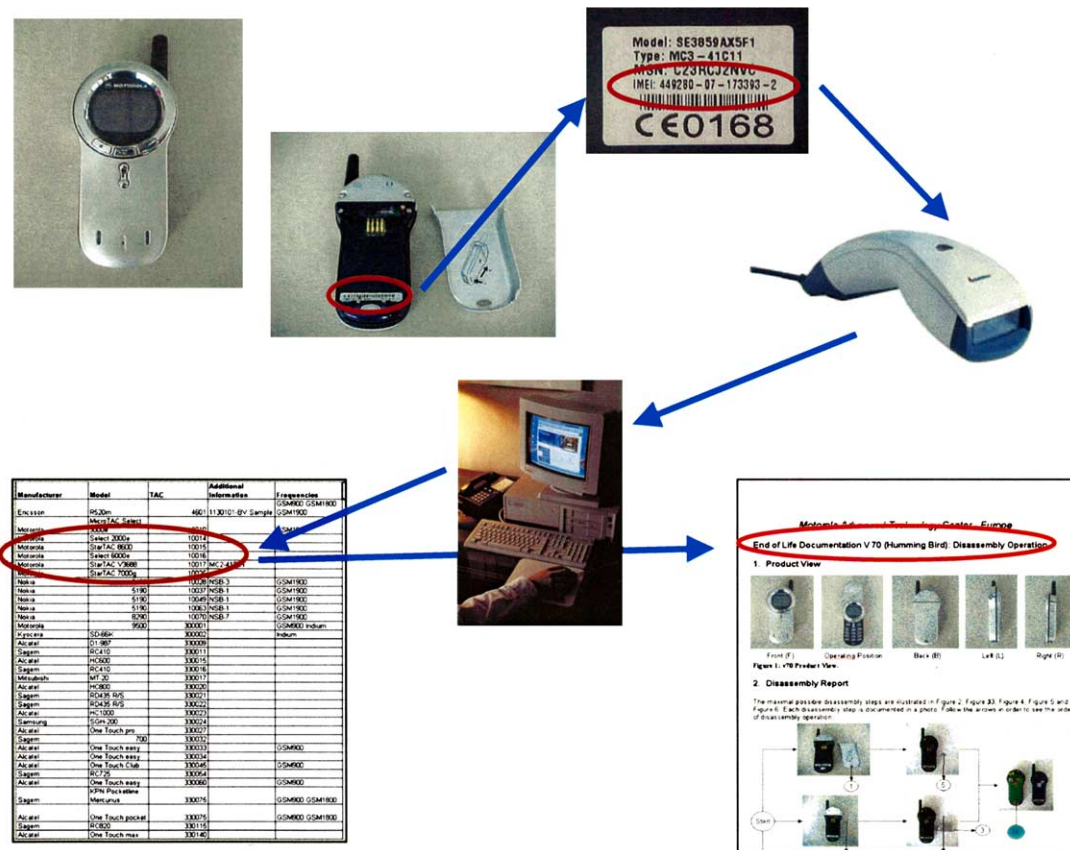


Fig. 1. Proposed system for linking product bar codes to information for recycling. A bar code underneath the cell phone battery can be read with a bar code scanner (or typed in manually) into a computer software application that looks up the bar code number in a database, and links automatically to a web page with dismantlement information corresponding to the specific model of the cell phone. Reprinted with permission from Thomas, 2003b. Copyright 2003 American Chemical Society.



Fig. 2. Label on a European cell phone, underneath the battery. The IMEI number 448835-09-86675-8 is printed on the label and below the numbers is also encoded as a 128 bar code.

act make and model of the product and automatically be shown the correct dismantlement information. Such a system is quick and requires no manual typing.

This system uses bar codes that are already on products, so there is no need to make new bar code labels or wait to implement the system. The proposed system makes use of a bar code label found on most European cell phones. This bar code label is usually underneath the battery, as shown in Fig. 1.

This bar code label contains the cell phone international mobile equipment identity (IMEI) number, shown in Fig. 2. This number is used for all cell phones that operate under the global system for mobile communications (GSM) protocol. This is the standard system for cell phones not only in Europe, but also in over 100 countries worldwide (Scourias, 1997).

The full IMEI number contains 15 digits and uniquely identifies each phone. For this recycling application, it is only necessary to know the make and model of the phone. This information is contained in the first six digits, which is called the type approval code (TAC). A TAC database is available on the internet (Nobbi, 2003). Because this code is standardized, it can be used to identify cell phone models in all countries that use the GSM protocol.

There are a number of ways that a computerized system could be set up to receive bar code information and to use that information to find a corresponding web site. For demonstration purposes, we developed a Windows application written in C++, which can be used on computers using standard Windows operating systems. Fig. 3 shows the user interface of this demonstration software, which is set up to work for several models of cell phone. The software contains the IMEI TAC number for these cell phones and the web addresses of the corresponding dismantlement reports.

As an alternative to using a bar code scanner, the user can manually type the phone's model number, IMEI number, code name, or other distinguishing information into the text

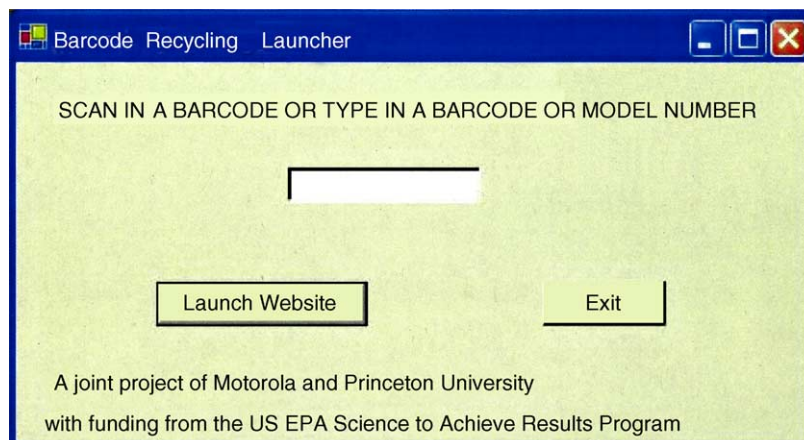


Fig. 3. Dialog box of the demonstration Windows application to link bar codes to product disassembly information. The user can scan or type the IMEI bar code.

box in the Windows application to open the disassembly information. Multiple names and numbers can link to the same phone's information. Copies of this demonstration software are available from the authors on request.

Based on the input information, the software links to a web-based disassembly report corresponding to the product's model. The disassembly report contains a step-by-step description of the disassembly sequence and information on the location and the type of hazardous substance used (Fig. 4). These reports could also include information on maintenance, reuse, upgrade and refurbishment of products.

4. Implementation

Recyclers typically manage products from many different manufacturers. Thus, useful implementation of this type of system would require participation of a number of the major manufacturers. Management of the information system could be organized by any of the several electronics industry organizations.

In the near term, the WEEE Directive will drive implementation of cell phone recycling in the European Union. But cell phone recycling is also being discussed in other parts of the world. In December 2002, leading mobile phone manufacturers signed an agreement with the United Nations Environment Program, within the framework of the Basel Convention, on environmentally sound management of end-of-life mobile phones (UNEP, 2002). The mobile phone agreement does not yet include any specific actions. But because the Basel Convention is global in scope, the mobile phone agreement has the potential to develop into a global system for end-of-life management of mobile phones and other products.

In the United States, representatives of industry, government and non-profit organizations have been discussing development of a nationwide electronics recycling system, the National Electronics Product Stewardship Initiative (NEPSI, 2003). In the absence of a

End of Life Documentation V 70 (Humming Bird): Disassembly Operation

1. Product View

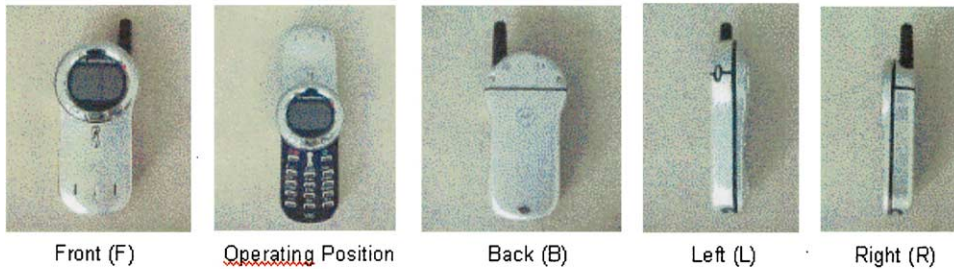


Figure 1: v70 Product View.

2. Disassembly Report

The maximal possible disassembly steps are illustrated in Figure 2, Figure 3, Figure 4, Figure 5 and Figure 6. Each disassembly step is documented in a photo. Follow the arrows in order to see the order of disassembly operation.

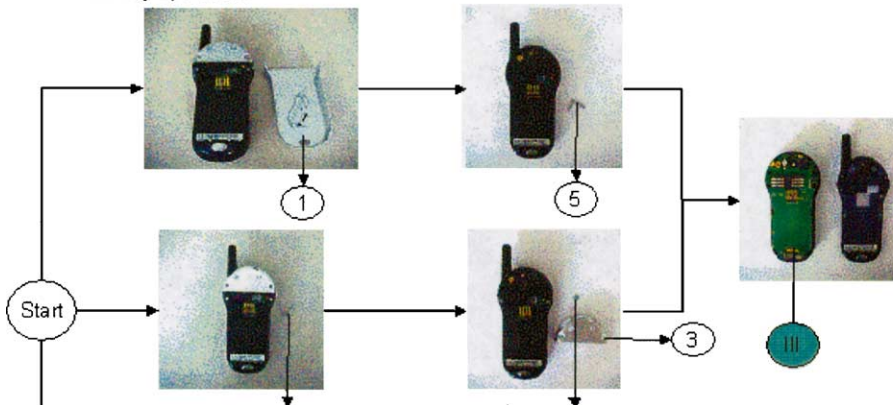


Fig. 4. Part of a disassembly report for a cell phone.

nationwide program, companies including ReCellular and CollectiveGood have begun to collect phones for resale in developing countries. Although reuse is completely different from recycling, reuse can have significant environmental and economic benefits (Thomas, 2003a).

As discussed above, the standardized labeling of GSM cell phones makes the opportunistic use of product bar codes for end-of-life management possible (Thomas, 2003b). As far as we know, cell phones that do not use the GSM system do not have a similar standard bar code label. A bar code linked system that could be used on any phone in the world would most likely require the development of a new label. Since the average life of a cell phone is estimated to be 18 months (Fishbein, 2002), a globally standard bar code label could be used in cell phone recycling within several years of its introduction. The use of a

standard label on all cell phones might be usefully discussed in the framework of the Basel Convention's Mobile Phone Initiative (UNEP, 2002).

The specific system discussed here is designed for implementation by product manufacturers and for use by recyclers and dismantlers. But there are a number of potential users of barcode-linked product information, and the specific design and content of the system could vary significantly for different users. For example, a system designed to help consumers recycle their cell phones could be developed by manufacturers, a government agency, or an environmental organization, and would contain information on where to send the phone for recycling and reuse. Yet another type of system might be developed by a cell phone recycling company, to contain internal information on what to do with different cell phones and cell phone parts.

Implementation of this type of system for European cell phones could be relatively straightforward because these cell phones already have a standardized bar code that indicates the make and model of the phone. Other electronic equipment does not have such labels. Manufacturers should be encouraged to include basic product information on the product, both as a written label and as a bar code. As with the cell phones, this information would need to be standardized so that users could easily access information from all manufacturers.

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