more granular than self-reported data. Therefore, electronic measurement of exposure to a medium is often perceived as enabling that medium to be more "accountable." There is fear that advertising in magazines and newspapers may suffer if advertisers believe that print cannot be held accountable because it isn't measured electronically. Moreover, in multimedia plans, it is feared that print will lose if it is the only medium whose effects cannot be expressed in an electronic metric. As Andrew Swinand, Senior VP-General Manager of Starcom Worldwide, put it, "In the rest of the media world, technology is enabling finer metrics of accountability. If print doesn't embrace new forms, it will be left in the dust." (Swinand 2005)

What "new forms" are really available to magazines and newspapers? Unlike television, radio, and the Internet, magazines and newspapers do not have any kind of electronic trail. Unlike outdoor ads, they are not stationary; so, they cannot be pinpointed geographically. Magazines and newspapers that are produced on the World Wide Web can perhaps be measured the same way that Web sites are measured. But how can old-fashioned paper be given the capability to produce electronic footprints?

Hopes for doing so rest primarily with a technology known as Radio Frequency Identification or RFID. Roberta McConochie of Arbitron and Jane Bayol of Time Inc. raised this possibility at the Worldwide Audience Measurement Conference in Geneva in 2004 (McConochie and Bayol 2004). In June of this year, Mediamark Research in the U.S. announced that it had signed an agreement with a technology development firm to explore the possibility of measuring exposure to magazines with RFID technology.

While there have been no known tests of this technology to measure exposure to print, it is helpful for print researchers and consumers of print research to have a rudimentary understanding of what this technology is, how it works, its current capabilities and uses, its potential for providing information about magazine reading, and its limitations in serving as a means of producing audience estimates for print. These topics, along with some background on the RFID industry, are covered in this paper.

DESCRIPTION OF THE TECHNOLOGY

The term "RFID" refers broadly to "technologies that use radio waves to automatically identify people or objects," according to the *RFID Journal*'s Web site ("Frequently Asked Questions," rfidjournal.com). Another way to think of RFID systems is to view them as advanced, microprocessor-driven bar coding technologies. As Robin Koh, Director of Applications Research at the Auto-ID Lab at MIT, put it, RFID is roughly equivalent to "a bar code that barks." (Harris 2004)

The technology is primarily used for two purposes:

- To keep track of things, such as products moving through a supply chain or livestock in a herd; and
- To identify people or objects, such cars passing through a toll plaza or people who are trying to get into an office.

In spite of its similarities to bar coding, RFID technology has not been used extensively for identifying products at the retail level. Only a few stores, such as Metro's Future Store in Rheinberg, Germany -- a testing ground for RFID technology in a retail environment -- place RFID tags on individual items (Mulligan 2004). RFID has also not been widely used in market research.[1]

There are three main components in an RFID system – a transponder, also known as an "RFID tag;" a scanner, which is usually referred to as a "reader;" and "middleware," the hardware and software needed to transmit the RFID data to a central server and process those data. The basic elements of an RFID tag are a microchip and an antenna coiled around it. A unique identifying code is embedded in the microchip. Tags come in a variety of form factors. An RFID reader is essentially a radio that sends and receives electromagnetic waves. If the tag is within a particular range of the reader, the tag's antenna receives the waves and sends back the ID code from the microchip to the reader at a different frequency. The reader's antenna picks up this frequency and sends the data from the tag to a central server.

There are a number of different kinds of RFID tags:

- Active vs. Passive: There are two basic kinds of tags: "Active tags," which are powered with an internal battery, and "passive tags", which are powered through the electromagnetic field created by the reader. Passive tags are the most commonly used. They have a shorter range than active tags, but they are smaller, are less expensive, and last for decades. The most common form factor for passive tags is a label, often referred to as a "smart label." Photos of some passive tags are shown in the Appendix. Though most passive tags can be read from no more than a few feet, some passive tags can be read from longer distances – 15 feet, according to one source (HighJump Software 2004). The cost of passive tags generally ranges from 20 to 40 cents apiece, but can be as high as a few dollars. ("Frequently Asked Questions," rfidjournal.com; Jackson 2005)

  Active tags are more expensive, with prices ranging from $10 to $100 ("Glossary," technovelgy.com; Sweeney 2005). They last only as long as the batteries within them last. Their advantages are their greater range – up to 100 feet – and their ability to expand the power of the tag in two ways described below.

  There are two other, less common configurations for RFID tags. "Semi-passive tags" contain a battery to power the integrated circuit in the tag but not to transmit signals from the tag. Chipless tags – tags without integrated circuits that consist primarily of just an antenna -- are used when a unique identification code isn't necessary. (Sweeney 2005; "Glossary," technovelgy.com)

- Read only vs. Read-Write: The chips in some tags cannot have any information written to them, while some tags, particularly active tags, have the capacity to update the data on the chip with new information.

[1] AC Nielsen has participated in the Auto-ID Center and Auto-ID Labs at MIT, one centers for bringing together companies that are interested in RFID (Lederer 2003).

- Enhancements with sensors: Tags can be attached to sensors that can monitor changes in temperature, moisture, freshness of a food, the presence of radiation or chemicals nearby. It is generally more feasible to combine sensors with active tags than passive tags. ("Frequently Asked Questions," rfidjournal.com; "Glossary," technovelgy.com)

Tag readers are also produced in several different forms. They can be built into hand-held devices that are attached to terminals, like bar code scanners; or they can be embedded in mobile data collection devices; or they can be mounted in particular places, such as toll plazas or entrances to warehouses (Higuchi 2004). They range in price from $500 to $5,000, but typically cost at least $1,000. ("Frequently Asked Questions," rifdjournal.com; Bonasia 2005).

ADVANTAGES AND LIMITATIONS

As may be evident from the foregoing description, RFID tagging represents an improvement over bar coding in several respects:

1. Data storage capacity: RFID tags simply hold more information. A typical passive RFID tag stores an Electronic Product Code (EPC), which is comparable to the Uniform Product Code used in bar coding (UPC). Traditional bar codes contain 12 digits, and are in danger of running out of combinations. (Gilbert 2003) The EPC, in contrast, contains 96 bits of data, a sufficient amount to identify not just the manufacturer and the product (which are also identified by the UPC) but also the serial number of the individual item. For example, the bar code on a magazine will identify the magazine's title, but if that magazine were given a passive RFID tag, it would contain a unique serial number with information about the specific copy of the magazine, including the issue date, the printing plant, whether it was a subscriber or newsstand copy, etc. Tags can carry more data than just an EPC code. Some are designed to store as much as 512 bits of information. (Sweeney 2005)

2. Write capability: Some RFID tags can be written to as well as read from, after they have been put into production. It is not possible to update the information in a bar code, after the coded item is in production.

3. Line-of-sight reading: In order to read a bar code, a scanner has to be aimed at the bar code and there can't be any other materials between the scanner and the bar code. RFID tags need to be near a reader but do not have to be in the reader's line of sight in order to be detected. This difference underlies another advantage of RFID -- greater flexibility in placement of the code. Bar codes need to be printed directly on the outside of a product's packaging. RFID labels can be applied to the inside of the packaging or on the product itself.

4. Multiple items at a time: Bar codes have to be scanned one at a time. Tag readers can scan multiple items at the same time, though there are limitations on readers' ability to scan items that are closely packed together.

5. Labor-saving: In order to read a bar code, a person needs to hold the scanner near the coded item. Most tag readers can be posted at stationary points, from which they can detect the presence of the tagged items in their vicinity. Such a system reduces the need for clerks, freeing them up to concentrate on other functions.

6. Greater accuracy: RFID technology holds out the promise of higher levels of accurate identification of each object.

Of course, RFID tags are more expensive than bar codes, which cost less than a penny each. In addition, bar codes are so ubiquitous now that they are virtually invisible. RFID labels cannot be completely unobtrusive. They may be small, but on smaller items, it may be hard not to notice them.

In addition, it is important to note that RFID technology does have some technical limitations that are imposed by the laws of physics – limitations which could make them problematic for print research:

- RFID signals can be blocked by metal and liquids.
- RFID signals can be distorted by interference from other radio signals. In particular, RFID signals are more difficult to read when in the presence of many other RFID signals. This is a problem referred to in the industry as "tag collision." It is not yet possible, for instance, for a tag reader to automatically distinguish all of the grocery items bundled closely together in a grocery cart without taking each item out, one at a time (Want 2004).
- RFID systems are not yet capable of determining the distance between the tag and the tag reader.

HISTORY AND USES OF RFID

RFID represents the marriage of two broadcast technology and radar technology. Radio technology was first developed in the 1890s, and the birth of radar followed in the 1920s. Radar's development was spurred by World War II, when it was used by the Allies to help pilots distinguish between friendly and enemy airplanes. Not long afterward, in October 1948, an engineer named Harry Stockman wrote what is thought to be the first published work on RFID, a paper called "Communication by Means of Reflected Power" (in *Proceedings of the IRE*, pps. 1196-1204, October 1948).

It wasn't for another two decades that RFID technology was first employed in commercial applications, in systems to deter theft. This use of RFID, which is referred to as Electronic Article Surveillance (EAS), remains one of RFID's most common applications today. While a number of companies, laboratories, and government agencies were working to develop RFID during the 1970s, there was little further commercial development until the mid-80s. In 1987 after many years of testing, the first automated toll collection system using RFID technology was launched in Norway. Two years later, RFID-enabled toll collection systems began operating in the United States, one in Dallas and one to collect tolls from buses in New York's Lincoln Tunnel (Landt and Catlin 2001).

It wasn't until this time that RFID technology and the other technologies on which it relies – integrated circuits and communications networks – were sufficiently advanced to allow for widespread and multiple applications. In the last 15 years, RFID has expanded rapidly. RFID is currently used for . . .

- Automated toll collection: This is probably one of the most familiar applications of RFID technology – an active tag placed on a car windshield whose presence is registered by a large tag reader when the car drives through the toll. Afterward, the driver's account is automatically debited to pay for the toll.
- Security systems for buildings and offices: Employees of many companies are issued security cards with passive RFID tags in order to control access to their offices or other offices within the company.

- Theft prevention: As noted above, this is the oldest commercial application of RFID technology. RFID tags placed on cartons as they move through a supply chain are used to help prevent theft from employees working along that supply chain.
- Prevention of pharmaceutical counterfeiting: In November, 2004, a few major pharmaceutical companies, in cooperation with the Food and Drug Administration in the United States, began placing read-write RFID labels on medicine bottles before they are shipped out from manufacturing plants. When pharmacists receive these bottles, they can check on the bottles' history by scanning the tags. Bottles with unusual delivery histories or unreadable tags can be flagged. This effort is intended to reduce counterfeit drugs that have entered the distribution chain through unscrupulous employees who replace real drugs with imitations. (Harris 2004; Fox 2004)
- Automobile immobilization: An RFID tag in a car key is identified by a tag reader in the car's engine so that the car cannot be started without the key.
- Passive car entry systems: RFID technology is also used to allow drivers with electronic keychains to open the doors to their cars – and other cars – without placing their keys in their cars' locks.
- Inventory tracking: One of the most common uses of RFID technology is to enable manufacturers and retailers to know the whereabouts of every pallet or case of goods as they move through a distribution chain, from factory to warehouse to retail store.
- Animal tracking: RFID tags can be suspended to the ears of livestock in order to keep track of them.
- Managing library books: Libraries in San Francisco, Seattle, and Grapevine, Texas are placing passive RFID tags in library books to speed check-out and keep track of books more efficiently. (Harris 2003; Godinez 2005)
- Accelerated payment: In 1997, Exxon Mobil introduced an RFID-equipped keychain called SpeedPass that loyal customers can wave at tag readers on refueling tanks in order to have the cost of the refill automatically debited from their accounts. MasterCard is testing a similar program with McDonald's called PayPass, and American Express has conducted a pilot program with CVS drug stores called ExpressPay. (Godinez 2005).

Other emerging applications of RFID technology include:

- Luggage handling: Delta Airlines and some airports have conducted a number of experiments with RFID by sticking RFID tags on passengers' bags to reduce the amount of lost luggage. Because of the airlines' financial troubles, these efforts have largely been abandoned for now.
- Preservation of currency: The EU has explored the embedding of RFID tags in Euro notes with high dominations to curb counterfeiting and money laundering (Wan 2004; Jackson 2005).
- Document security: The U.S. State Department is considering the possibility of embedding an RFID tag in new U.S. passports (Koppel 2005).
- Freshness screening: Sensors connected to RFID tags on items in a grocery store and tag readers on store shelves could identify expired cartons of milk or cups of yogurt and alert the store manager.
- Self check-out: One of the visions for the future is that if every item in a grocery store or drug store were tagged with a passive RFID transponder, an entire shopping cart of groceries or other purchases could be tallied automatically by rolling the shopping cart by a powerful RFID tag reader.

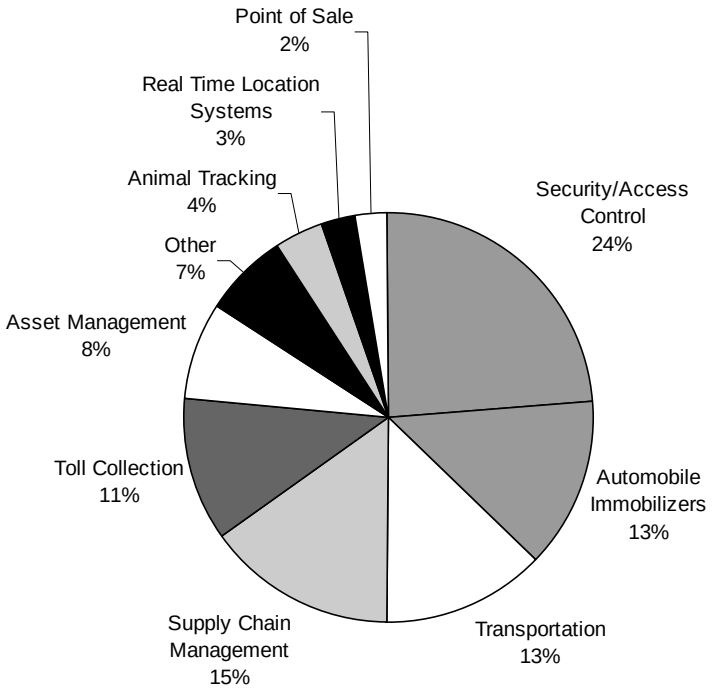
- Research on shoppers: If all items in a grocery store are tagged, and all grocery store shelves are equipped with tag readers, then it would be possible to know how quickly items are selling in real time and how often products are picked up and put back on the shelf. This sort of information could be useful to the retailer in reducing stock-outs and to manufacturers in evaluating labeling or packaging.
- VIP screening: A nightclub in Barcelona admits customers to its VIP room who have a "Verichip" implanted under their skin and allows their drinks to be automatically billed to their accounts (Koppel 2005).

THE RFID BUSINESS LANDSCAPE

The global RFID business is clearly growing, but its rate of growth is not well documented. Since RFID crosses many different traditional industries, there are no definitive data on national or international expenditures on RFID. One often-quoted consultant, the Venture Development Corporation (VDC), has estimated that the global market for RFID technology grew 23.5% between 2003 and 2004. VDC forecasts that RFID revenues will grow at an annual rate of 35.6% from 2004 to 2008 (Liard 2005).

Estimates of the breakdown in expenditures for RFID hardware among general categories of RFID applications in 2003 (the latest year for which these estimates were available) can be seen in Chart 1. Security/access control is the largest category, with 24% of the total. Though toll collection is one of the most visible RFID applications, it ranks fifth.

Chart 1: Global Shipments of RFID Hardware by Primary Application - 2003



Source: Liard and Reinhardt, 2003.

Of the seven major categories, supply chain management appears to be the fastest-growing:

	% Increase in Total Revenue 2003-2004
Supply Chain Management	39.5%
Asset Management	18.6%
Transportation	16.0%
Animal Tracking	15.7%
Toll Collection	8.2%
Security/Access Control	7.5%
Automobile Immobilizers	5.4%

Source: Liard and Reinhardt, 2003.

Indeed, VDC predicted that by 2008, supply chain management would become the most common use of RFID technology, in dollar terms. VDC also projected that some of the smaller categories would grow very rapidly, with baggage handling ranking second and point-of-sales systems ranking third in total revenues among RFID applications by 2008 (Liard, 2005).

Currently, the traditional industry that consumes more RFID services than any other appears to be the automotive industry. According to a 2003 report by Allied Business Intelligence (ABI), the automotive industry accounted for 46% of the RFID market. (Ferrell 2003)

The RFID industry is still fairly young. Estimates of the total spent on RFID products and services in 2004 range from $1.5 billion to $1.75 billion (Rashid 2005a; Liard 2005) – far lower than worldwide expenditures on marketing and opinion research (though roughly more than total worldwide expenditures on print research). The Americas represent a slightly larger share of the global market than Europe: 43.6% of the money spent on RFID hardware (i.e., tags and readers) in 2002 went to the Americas, compared to 38% for Europe. (Liard and Reinhardt 2003)

In spite of the industry's youth and relatively modest size, many blue chip companies are involved in the production, testing, or use of RFID:

- One of the key forces driving the growth of RFID in the U.S. has been its enthusiastic embrace by Wal-mart, the world's largest company. In the summer of 2003, Wal-mart announced that it was mandating its top 100 suppliers to put RFID tags on all cases and pallets sent to its three regional distribution warehouses in Texas by January, 2005. According to Wal-mart, nearly all of these suppliers complied. In addition, a number of other Wal-mart suppliers began RFID-tagging their cases and pallets, bringing the total of suppliers using this technology to 137. Wal-mart subsequently announced that it will be requiring its top 200 suppliers to apply RFID tags to all cases and pallets shipped to 12 distribution centers and 600 stores by January, 2006. (Sullivan 2005)

- Following Wal-mart's lead, Target, Best Buy, Albertson's (a US supermarket chain), and German retailer Metro AG announced that they were requiring their top suppliers to begin tagging cases and pallets sent to them. It is not surprising, then, that supply chain management is believed to be overtaking the other applications as the most prominent application of RFID technology.
- The U.S. Defense Department also began requiring that its biggest suppliers adopt RFID technology in its shipments to the military.
- Phillips and Texas Instruments are among the leading RFID system manufacturers.
- IBM, Microsoft, Oracle, and Sun have begun offering services to manage the data generated by RFID systems. (Feder 2004b) IBM, in particular, has aggressively promoted its services, announcing that it was investing $250 million over five years and hiring 1,000 people to work on RFID systems (Buss 2004, Feder 2005).
- Tesco, the UK's largest retailer, has been testing tags on its "high-value and frequently-stolen merchandise." (Guest 2005)
- Other companies that have tested or deployed RFID systems include Benetton, Gillette, Woolworth, Hewlett Packard, CBD (the largest grocery retailer in Brazil), Kimberley-Clark, Procter & Gamble, McDonald's (with PayPass), MasterCard, American Express, and Exxon-Mobil (SpeedPass).

This roster of well-known companies is supported by hundreds of vendors of RFID products. There are over 500 of these companies listed in the *RFID Journal*'s database of suppliers. One of the largest suppliers, Alien Technology, raised eyebrows two years ago by receiving an order from Gillette for 500 million tags. Another prominent supplier of RFID products, Matrics Inc., was recently acquired by Symbol Technologies, one of the leading manufacturers of bar code readers (Rashid 2005a).

This level of activity would certainly appear to be encouraging for developments on the RFID frontier. However, it would be difficult to characterize it as an RFID revolution. Many companies in the retail sector or serving the retail sector have been slow to embrace the possibilities of RFID technology. The 137 companies that have begun to implement RFID systems for Wal-mart represent less than half of one percent of Wal-Mart's 68,000 suppliers (Ballard 2005). A survey of large European retailers by ECR Europe, a retail trade organization, found that just nine percent of them were "evaluating" RFID applications (Ballard 2005). There are several reasons that RFID growth has not been more rapid, some of which have implications for the use of RFID technology to conduct research on magazines:

1. Lack of standards: According to a survey of 114 business-technology executives conducted by *Information Week*, the number one "challenge" in considering adoption of RFID technology is the lack of universal standards in the RFID industry. (Bacheldor 2005). Without accepted international standards, goods that are tagged by one company in a supply chain may not be readable by another company's readers. There has been notable progress on this front in the last two years with respect to EPCs, but there are a number of areas in which internationally accepted standards continue to lag.

2. Cost: Even though costs of tags and tag readers have been falling, they remain too high for some companies, particularly for smaller ones. This was the second-most frequently cited "challenge" among respondents to the *Information Week* survey. (Bacheldor 2005).

3. Evolution in technology. With so many companies providing RFID services, it can be difficult for businesses to determine which company's solution would work best for them. In addition, rapid advances in RFID systems have heightened some companies' concerns about investing in a system that could become antiquated – and possibly cost less -- a short time later.

4. Sense of coercion. It appears that many suppliers to Wal-Mart, Target, and the other retail chains that have been subjected to supplier mandates harbor grave doubts about the benefits of RFID technology, perhaps because of discontent about having it foisted upon them. (Nairn 2005) Many of the Wal-Mart suppliers that were required to adopt RFID technology apparently did so half-heartedly, performing the bare minimum required to comply with the mandate. A consulting firm called Incucomm estimated that these suppliers spent an average of about $500,000 to comply with the mandate – half of the amount that analysts expected. (Pethokoukis 2005)

5. Inflated expectations. It appears that all of the "hype" about RFID has raised expectations to the point that some companies feel that the RFID industry has over-promised and fostered confusion.

6. Privacy concerns. While the development of EPC standards has been cheered by those working in the industry, these standards fan the fears of privacy advocates. RFID technology has already spawned an advocacy group dedicated to resisting its application in the retail sector – Consumers Against Supermarket Privacy Invasion and Numbering (CASPIAN). Founded by a Harvard graduate student in educational psychology named Katherine Albrecht, CASPIAN objects to the power of RFID tags to provide retailers with a lot more information about their consumers than they currently have and their potential for allowing one retailer to identify an item purchased at another retailer. CASPIAN has further claimed that RFID tags could be used by the government or companies to track people's movements or could be used by high-tech thieves to uncover the contents of consumers' houses, cars, or backpacks. Albrecht has equated RFID to "an electronic frisk or a form of X-ray vision." (*RFID Connections* newsletter, 2004) From a scientific standpoint, some of the fears of the privacy crusaders have little merit. Human bodies and the presence of other radio signals can block RFID signals; RFID tag readers can't penetrate metal in cars, and tag readers that would be powerful enough to spy on homes and people's movements could not be easily concealed.

   Two RFID experiments have already been derailed by CASPIAN and its allies. A test by Benetton to insert ID tags into its clothing labels for its owned-and-operated stores; and a test by Gillette at a Wal-mart in Massachusetts and a Tesco store in the UK to install tags in packages of Gillette razors that were to be monitored by "smart shelves" with tag readers and shelf-mounted cameras to prevent theft. (McHugh 2004) Negative publicity and the threat of boycotts prompted the companies involved to cancel those tests. In response to privacy concerns, RFID manufacturers have begun producing tags with "kill switches" which, when applied at the point of purchase, disable the tags.

USING RFID TO PASSIVELY MEASURE MAGAZINES – THE VISION

On the surface, this technology would appear to be wonderfully suited to market research on exposure to print. A magazine researcher might imagine that some day in the future, when all items sold in retail stores contain RFID tags, all newsstand copies of magazines would have such tags. It would require little additional effort, one might imagine, to affix such tags to all magazine copies, including those sent to subscribers and distributed on airlines. Magazines would then be capable of leaving an electronic trail, just like radio, television, and the Internet. In a further flight of

fancy, a print researcher might even assume that RFID tags would be attached to every page in every magazine and newspaper, or at least every page with an advertisement.

What a brave new world for print research this would be! All one would need to do would be to recruit a panel of respondents, perhaps in the same way we do now, and equip them with portable tag readers that they would be asked to carry with them everywhere they go, like the PPM or Mediawatch. Whenever panelists came in sufficiently close contact with a magazine, the portable scanner would register the magazine's presence and store information on the magazines' title and issue date. Perhaps these exposure events would be time-stamped. Perhaps the portable scanners would be able to monitor exposure to the individually-tagged pages as well.

This vision would herald benefits for researchers, publishers and advertisers. From a researcher's standpoint, relying on an electronic, passive means of determining readership would eliminate many of the measurement problems we have faced and explored:

- Audience estimates for print would no longer rely on respondents' memories;
- Title confusion would disappear, because the tags for different magazines would carry distinct ID codes;
- Social desirability biases in reported readership would disappear (though it is possible that they would be replaced by biases arising from respondents' willingness to carry the scanning device more frequently when reading some magazines than when reading others);
- Problems in measuring magazines with lots of special issues or unusual publishing frequencies would disappear;
- And the model bias of using recent readership to estimate average issue audiences, due to parallel and replicated reading, would no longer be relevant if the period that respondents were asked to carry the scanning devices were sufficiently long.

Advertisers should be excited by this scenario because it would presumably . . .

- Enable us to obtain audience estimates for individual issues;
- Enable us to estimate audiences for individual pages and, therefore, individual ads;
- Provide measures of the amount of time spent with individual ads;
- Enable us to track exposure to a magazine over-time to measure the number of readers a magazine adds each day or each week, without any statistical modeling;
- Enable us to track the way in which exposure to individual magazines builds over time;
- To measure the number of times readers were exposed to individual ads.

Publishers, too, would love this scenario because it would . . .

- Provide estimates of the number of times all readers pick up a particular magazine;
- Provide measures of the actual, rather than reported, amount of time that their readers spend with their magazines;
- Perhaps provide estimates of the amount of time readers spend with individual articles;
- Perhaps enable magazines to report their audiences frequently, even on a daily basis, which would allow them to compete more effectively with television.

PROBLEMS WITH THIS VISION

Alas, this vision clashes with current reality on three major fronts: cost, privacy concerns, and technical limitations of RFID.

- Cost. As noted earlier, the lowest-priced passive tags still cost 20 cents apiece. Adding 20 cents to the production cost of every copy of a magazine in the print run of every issue would simply be prohibitive.

  It is true that the cost of passive RFID transponders has fallen substantially since the early part of this decade, when they cost a minimum of 50 cents (Haughlett 2005). A number of experts believe that within the next five years, the price of a passive tag, when ordered in large quantities, will fall to five cents – generally considered the point at which it would be worthwhile for manufacturers to place tags at the item level. Even if the cost of passive RFID tags were to fall to five cents (and it is doubtful that it could fall much lower), the cost of tagging every copy of every issue of a magazine would still vastly exceed the amounts that publishers now pay for measurement of their audiences. A weekly magazine with a print run of one million copies, for example, would have to pay an additional $2.6 million per year ($.05 * 1,000,000 * 52) to tag every copy. If the average length of the magazine is 100 pages long, tagging every page would cost $5 per copy, more than the newsstand price of all but the most rarefied magazines.

- Privacy concerns. The research community might regard a portable tag reader as no more intrusive than a PPM, a Mediawatch, or push-button set meter. However, as noted above, the use of RFID technology in consumer goods has already aroused suspicion and resistance among vocal privacy advocates. This segment is bound to be hostile to the placement of RFID tags in magazines and is likely to try to alarm the public about it. The RFID industry has countered the concerns of privacy advocates by saying that RFID tags in items at the retail level could be disabled at the checkout counter after the item has been paid for. This solution won't work for research purposes, of course, because it would cover subscriber copies and because it would preclude the measurement of the audience of newsstand copies after they have been paid for.

- Limitations of the technology. The current generation of RFID technology is simply not as powerful or as sensitive as it would have to be to fulfill the vision described above.

  1. Size of the tag reader: The range of a tag reader depends to a degree on the length of its antenna. The longer the antenna, the more powerful the battery has to be. Therefore, tag readers are generally too big to be easily carried around – larger than a PPM or Eurisko Media Monitor or a wristwatch. It is currently possible to produce tag readers that are smaller, with smaller antennas and less powerful batteries, but their range would also be smaller. A panel could be equipped with smaller portable tag readers that could be clipped to belt, but in order for a panelist's magazine reading to be recorded by such a device, the panelist would have to bring the device up close to the magazine (or bring the magazine close to the device). This is not quite the sort of purely passive measurement afforded by devices like the Mediawatch or the PPM. Indeed, real-time electronic measurement of magazines requiring respondent action whenever the respondent reads a publication can be accomplished without RFID technology. The GfK Mediawatch, for example, includes a small display screen that can be used by respondents to record the newspapers and magazines they are reading, as they are reading them. The Eurisko Media Monitor includes the capability of recording respondents' voices for several seconds at the press of a button so that respondents can record the titles and issue dates of the publications they pick up.

2. Identification of a reading event. If it were possible to overcome the problem above and produce a portable tag reader with a range of more than a few inches that is not too bulky, then how could this device distinguish between a panelist reading a magazine and merely carrying it or sitting or standing next to it? Current RFID technology is not able to measure distance between the tag and the tag reader. Every time that a panelist went to a check-out counter to pay for groceries or sat in a doctor's waiting room in front of a table filled with magazines, the reader would register the presence of several magazines, perhaps for long periods. It would be extremely difficult to calibrate a system so that it only detects a tag in a magazine within a particular distance of a tag reader, under the assumption that this distance constitutes a reading event.

3. Tag collision. It is sometimes difficult for tag readers to read multiple tags that are close together. If every page of a magazine were tagged, their signals might be obscured.

4. Accuracy of measurement. RFID systems simply do not always function as well as they are designed to. While they can achieve "read rates" (successful identifications of the tag by the tag reader) of 100%, they often do not, at least initially. One article from 2003 claims that RFID systems "fall far below the 99 percent reliability rate" of bar code. (Humer 2003) A recent white paper notes that "field reports [are] citing read accuracy rates in ranges from 40% to 100%." (Liard and Reinhardt 2005) Another article from 2004 cites 80% as the level of accuracy of "today's reader devices." (Ha 2004) In order to improve accuracy rates, experiments need to be conducted with the position of the transponder, the tag reader, and the antennas. Interference from other radio waves, liquids or metals needs to be taken into consideration. Since RFID has not been used for the purpose of measuring exposure to print and since objects that are tagged are usually thicker and less flexible than a magazine or newspaper and newsprint, it may turn out to be difficult for tag readers to detect transponders inside magazines. It would be necessary to conduct extensive testing to obtain "read rates" of 100% or close to it. Such testing could take quite a bit of time, perhaps years.

5. The physical make-up of newspapers. It would be more difficult to attach any kind of RFID tag to newspapers than to magazines due to the physical composition of a newspaper. Magazines are bound together with stitching of some sort. This construction could allow tags to be physically bound into a magazine or affixed to a page; if affixed to a page, the tag would remain close to the other pages. Since newspapers are not bound together, it would not be possible to attach a tag to a binding. And if a tag were affixed to a page of a newspaper, that page could easily be separated from the others.

Because of these problems, the vision outlined above remains out of reach for the foreseeable future. This does not mean that it would not be worthwhile for researchers and publishers to begin to explore RFID technology for audience measurement or other kinds of print research. If RFID technology continues to advance, becomes much less expensive, and gains more acceptance among consumers, then it is possible for these problems to be overcome.

HOW USE OF RFID WOULD AFFECT READERSHIP RESEARCH

If these problems can be surmounted, another set of research issues would need to be addressed in order to achieve the vision outlined above. This vision assumes that the surveys we conduct of readership would simply be replaced by samples of people who would be asked to carry RFID tag readers instead of being asked to answer readership

questions. Such a shift would represent a profound transformation in the way readership research is conducted. Replacing readership questionnaires with RFID-based diaries of print exposure would affect almost every facet of print audience measurement, beyond the introduction of the technology:

1. Publisher cooperation: Readership surveys that employ the recent reading paradigm are free to include virtually any magazines they would like. It does not matter whether a particular publisher subscribes to the measurement service; the publisher's magazine or magazines can still be represented in the survey without the publisher's cooperation. At most, the readership survey requires a magazine's cover and logo, which can easily be scanned or pulled from the Web.

   This would not be the case if readership measurement were based on RFID technology. The only magazines that could be included in the study would be the magazines in which RFID tags had been placed. Therefore, switching from self-reports to RFID-based measurement would require the participation of every publisher whose magazine is covered in the survey. This would be a steep barrier to cross, particularly in countries where readership services are not commissioned by Joint Industry Committees.

2. Respondent cooperation: Arbitron's tests of the PPM suggest that respondents are less likely to agree to carry a device wherever they go than to answer a questionnaire. Replacing a questionnaire with a task that respondents have to perform for at least several weeks – carrying a portable device – would run the risk of further depressing what are already historically low response rates for print measurement surveys in most countries. Eliciting respondent cooperation with this task would be even more difficult for print audience measurement services that are currently fielded on the phone or the Web.

3. Study design: In order to adequately capture readership of monthlies and bi-monthlies, it would be necessary for respondents to carry the devices for at least one month, preferably two. Indeed, in order to achieve all of the gains from the switch described above, it would be necessary for respondents to participate for at least six months, if not a full year. This basic shift in the time frame of the data collection from each respondent implicitly converts the study from a static sample into a longitudinal panel. Turning a study from a cross-sectional design into a panel study has implications for the study's sample size, field administration, statistical estimation procedures, and costs. Each of these implications is discussed below.

4. Field administration: Managing a panel is more complex and more labor-intensive than administering a single-contact survey with one or two follow-up interviews. Additional field staff would need to be dedicated to answering panelists' questions, administering incentive programs, and *maintaining cooperation throughout panelists' tenure*. New panel management software would need to be developed or at least adapted for a readership study of this sort.

5. Cost: Assuming the same sample size and the same method of contacting the sample, a panel study employing portable RFID devices would almost certainly be more expensive than administering a questionnaire to a static sample. There are at least four additional expenses that would have to be borne:

   a. As noted above, additional field staff would need to be hired to manage the panel.
   b. Incentives to respondents would almost certainly need to be raised in order to both gain cooperation and maintain it through the period that respondents are required to carry the device.
   c. The volume of data that would need to be processed would dwarf that of one or two questionnaires.
   d. The tag reading devices themselves would certainly cost much more than printing questionnaires.

6. Technical problems: Just as there may be problems with CAPI software or the hardware on which it is being run, there may be technical problems with the RFID equipment given to respondents. However, the effect of equipment failure in a passive measurement device is very different from the effect of a computer crash or a problem with questionnaire software. If the research company finds no record of print exposure when it downloads data from the tag reader, this may mean either that there was no reading activity or that the device wasn't operating properly[2]. The respondent might not know that the device isn't working properly, and it may be difficult for the research company to discover this. The result would be that magazines' audience estimates would be artificially lowered because they would not be counting legitimate reading activity. Such a bias would, in turn, affect estimates of the frequency with which the magazine is read, distort copy velocity curves, and artificially lower estimates of audience duplication.

   If the respondent or the research company does know that there is a problem with the equipment, what should the research company do? Television researchers always have had to confront the problem of day-to-day variations in "in-tab" rates. This would be a new problem – and a more serious one -- for print researchers because magazine reading, in particular, is a much less frequent activity than television viewing. Magazine audience estimates would be severely affected if any reader of a bi-monthly or a magazine with a smaller audience was out of tab on the day that he or she read or looked into that magazine. Since fault rates would fluctuate from day to day, how would the in-tab samples from each day be combined to generate an estimate of average issue readership? This would be a major challenge to print researchers if they ever adopt an electronic method of gauging print exposure.

7. Qualitative data: Passive measurements of exposure to print simply could not replace all of the "qualitative" readership data that are collected in many countries now. No RFID reader would be able to measure source of copy, place read, interest in the editorial, interest in the advertising, actions taken because of the advertising, opinions about the magazine, and all of the other qualitative variables we currently collect on a self-reported basis. Given the industry's current interest in levels of engagement with magazines, clients of print audience research would not be eager to sacrifice these qualitative items. It therefore might be necessary to add follow-up surveys with the RFID readership panel or conduct surveys with different samples in order to retain these qualitative data.

8. Potential new sources of bias: While eliminating the interviewer and eliminating self-reports might eliminate biases due to socially desirable *responses*, other biases might arise due to respondents' *behavior*. Respondents' device-carrying patterns and reading patterns through the course of a day might generate such biases. If, for example, respondents are more likely to carry the portable RFID readers in the middle of the day than early in the morning, then publications respondents read early in the morning are less likely to be tallied than those they read in the middle of the day. Similarly, social desirability biases might persist in a subtler way if study participants "turn off" or take off their portable RFID scanners when they come in contact with magazines that they would be embarrassed to reveal that they read.

9. Sample size for estimating AIR: One of the purported advantages of a panel design is that it should allow for smaller sample sizes. After all, a panel provides repeated measures of a variable rather than just one measurement at a single point of time. If a panel were equipped with a passive print exposure monitoring device and asked to carry it for a long period than the publishing interval of most magazines – six months or 12 months – wouldn't the estimate of Average Issue Readership (AIR) be more reliable than the estimate from a recent reading survey questionnaire, at the same sample size? If so, then it would be possible to reduce the sample size and maintain the same level of robustness of the AIR estimates. Could the savings in

[2] It might also mean that the respondent hadn't been carrying the device all the time, as instructed, but presumably a motion sensor attached to the device would reveal this problem.

a smaller sample size offset the increases in costs due to passive measurement devices, panel management, more extensive data management, and increased incentives?

This issue is more complex than it may, at first, appear. It is true that the sampling errors of AIR estimates would be lower in a long-term panel with specific-issue measurement than from a recent reading survey with the same sample size. So, it would actually be possible to reduce the sample size in the panel study while maintaining the same level of sampling error as in the cross-sectional survey. However, the reduction in sample size would not be sufficient to compensate for the other increases in costs. This is because the size of the sample could not be reduced very much. The gains in reliability from measurement of specific issues are simply not that great for some magazines. The reduction in sample size would, of course, be dictated by the magazines whose efficiency gains would be smallest.

The efficiency gained by repeated measures depends on the degree to which the measures at different points in time are correlated with each other. If everybody in a sample provided the same answers at time 2 of a panel survey as they did at time 1, then no information would be obtained by executing a second measurement. So, there would be no value in measuring a sample a second time. In the case of magazines, if everybody in a sample read the same magazines every month, then measurements of 12 months of magazine reading would be no more reliable than measurement of one month. The greater the similarity between weeks in individuals' reading behavior, the smaller the advantage in having a panel for estimating average issue audiences. To put it another way, the lower the degree of turnover from issue to issue, the lower the reduction in sampling error from measurement of specific issues.

This is because multiple observations from a single individual are not independent. The observations in a panel are "clustered" within individuals. The greater the intra-cluster correlation – the correlation between readership at two random points in time -- the greater the design effect (DEFF). And, of course, the greater the design effect, the lower the effective sample size. In other words, for a panel of size n with k observations per person (52 for weeklies, 26 for bi-weeklies, 12 for monthlies),

$$\text{Effective sample size} = n/\text{DEFF}.$$

MRI has calculated the design effects for all of the magazines covered in its study, based on its estimates of the intracluster correlations for each magazine. The intracluster correlations, in turn, are based on the magazines' AIRs and the frequency with which they are read. From these design effects, we have calculated effective sample sizes for 26 weeks and 52 weeks of measurement in a panel (Frankel, 2005).[3] All of the data cited here and in Table 1 are from Frankel, 2005. Across 215 publications in the MRI study, the effective sample sizes range from 9% higher than MRI's current sample to 213% higher for a 26-week panel and from 11% higher to 243% higher for a 52-week panel. (See Table 1) For the purpose of gauging the extent to which the sample size (n) could be reduced in a panel design, though, the most important figures are the minimums, because MRI would still want to be able to report the same magazines as it currently does. For a 52-week panel, then, MRI would be able to reduce its sample size by no more than 10% without lowering the effective sample sizes for the magazines with the least level of intra-week correlations. For many magazines, the sample could be cut substantially with a six-to-12-month panel, but for others, the sample would need to remain at 90% of its current size.

[3] Frankel's estimates in this table are based on the work of G.P. Hyett and L. R. Frankel:

G. P. Hyett, "The Measurement of Readership," Statistics Seminar, London School of Economics, February, 1958.
L. R. Frankel, "The Role of Accuracy and Precision of Response in Sample Surveys," N.L. Johnson and H. Smith, Eds., *Developments in Survey Sampling*, New York, John Wiley and Sons, 1969.

10. Sample size for estimating readership of individual issues. One of the key benefits in the vision of an electronically-monitored panel described above would be the ability to measure audiences of individual issues. Specific-issue measurement would allow for the assessment of time-in-magazine advertising schedules, without modeling, including the number of readers each issue of a magazine accumulates over time (also referred to as "copy velocity").

The problem with this vision, from a research perspective, is that the sample size of a static readership survey dedicated to measuring AIR would not necessarily be large enough to measure readership of individual issues of every magazine in that survey. Since audiences of magazines and newspapers vary across issues, the sample size for measuring individual issues would have to be large enough to ensure reliable estimates of the ***issues*** *with the smallest audiences*. So, if the minimum reportable *average* issue audience for a readership survey is one million readers, then the minimum reportable audience for *individual* issues, with the same sample size, would also be one million readers. If there are issues whose audiences fell below that minimum then estimates of those issues' audiences would be unreportable: Their sampling errors would be unacceptably high. If the research company was committed to reporting audiences of every issue of every magazine in their current cross-sectional study, then the research company *would need to raise the sample size for the panel study.*

The minimum sample size for an RFID-powered panel study that intended to report audiences of individual issues would depend on the current readership study's sample size; the AIR of the magazine with the smallest audience for a specific issue; and the size of the audience of that issue. Let us use "Magazine A" to refer to the magazine in the current study with the lowest audience for any individual issue. If we assume that we would want to retain the same relative error (the ratio of the standard error of a magazine's AIR estimate to the AIR estimate) in the panel study as in the original static sample, then the minimum sample size for the RFID-powered panel would be . . .

$$n_2 = n_1 * (1-kp_A) / (k(1-p_A))$$

. . . where n_2 = desired sample size for the panel study
n_1 = sample size of current audience measurement study
p_A = proportion of the universe who reads an average issue of magazine A (i.e. AIR_A/total population)
z = number of readers of the least-audience issue of magazine A; and
k = ratio of z to the AIR of magazine A.

For example, the magazine in the MRI study with the smallest audience has an AIR of 0.5% of the total adult population. Let us assume that the issue of this magazine with the lowest level of readership is 0.3% of the population, or 60% of the average issue audience. The sample size required to maintain the same relative error standards as in the current static sample survey would be 67% higher than the current sample size (i.e. n_2/n_1 would equal 1.67). If the issue with the lowest audience were 75% of the magazine's average issue audience, then the sample would need to be 33.5% larger than the current sample in order to report that issue's audience with the same relative error rate as the current study.

Thus, exploiting RFID technology to fulfill the vision of measuring exposure to individual issues of magazines and newspapers would be technically challenging, politically difficult from the standpoint of both publishers and the general public, more logistically complex and prohibitively costly. It could also produce higher levels of non-response error and missing data for individual days from individual respondents. Any attempt to move print audience surveys in this direction should be mindful of these challenges.

There is also one final, more philosophical consideration that needs to be addressed in any attempt to embark on a project to measure print audiences with RFID technology. There remains the fundamental question of whether presence in the close proximity of a magazine, even an open magazine, can be considered equivalent to the act of "reading or looking into" it. Asking a respondent whether he or she read or looked into a publication implies a conscious process of absorption of material on a page. Presence in proximity to a magazine – even an open magazine -- may not be fully conscious. RFID signal detection is not necessarily related to where a reader's eyes actually are even if an RFID tag reader would be able to determine that a magazine is open in front of a person, it cannot determine whether the person is actually looking at the magazine.

Shifting from self-reports of reading to a passive electronic method of measuring readership is comparable to the shift that would occur in radio or television in moving from diaries to meters. A portable passive measurement system for radio or television proximity to a sound is considered equivalent to exposure to it. Publishers would like to believe that magazine reading requires a higher order of cognitive processing than listening to a radio or watching television. If measurement of print follows the same path as is currently being followed by radio, television, and even outdoor, would print lose a bit of its edge as an advertising medium? Would making the measurement of print comparable to the measurement of electronic media imply that the medium itself is equivalent to the electronic media? Passive measurement of print may not, ultimately, be beneficial for magazine advertising.

FINAL THOUGHTS

RFID is a powerful, potentially transformative technology. It may be possible and even desirable to harness its power to measure exposure to magazines or even exposure to individual pages for special studies or in particular, limited contexts. Any such effort would require considerable investment, sensitivity to privacy concerns, and extensive testing. However, any attempt to replace our current audience measurement surveys with an RFID-equipped panel study would be fraught with pitfalls for the foreseeable future. The current technology would simply not be feasible for this task. In addition, the promises of such panel could not be delivered without universal publisher cooperation, overcoming political risks, acceptance of additional errors and technical problems, and considerable increases in costs. RFID technology is worthy of further exploration for magazine and newspaper research. There may be at time when it can replace what we currently do. But that time has not yet arrived.

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References:

"Frequently Asked Questions," RFIDjournal.com.

"Glossary," Technovelgy.com.

"The ROI of Privacy Invasion." *RFID Connections*, newsletter from The AIM Global Network, January, 2004.

Bacheldor, B. (2005) "RFID in Pharma: Now, Rewards to Come." *Information Week*, March 28, 2005.

Ballard, M. (2005) "Not Really a Retail Revolution, Yet." *Financial Times*, April 20, 2005.

Bonasia, J. (2004) "Retailers Tune in to Radio Tags." *Investor's Business Daily*, March 16, 2004.

Buss, D. (2004) "The Race to RFID." *CEO Magazine*, November, 2004.

Dyson, E. and Dean, E. (2003) "RFID: Logistics Meets Identity." *Release 1.0: Esther Dyson's Monthly Report*, June, 2003.

Feder, B. J. (2003) "How to Find that Needle Hopelessly Lost in the Haystack." *New York Times*, September 29, 2003.

Feder, B. J. (2004a) "Keeping Better Track from Factory to Checkout." *New York Times*, November 11, 2004.

Feder, B. J. (2004b) "Wal-Mart Hits More Snags in Push to Use Radio Tags to Track Codes." *New York Times*, March 29, 2004.

Feder, B. J. (2005) "IBM's New Radio Tag Push." *New York Times*, June 15, 2005.

Ferrell, K. (2003) "RFID Finds Smooth Ride in Auto Industry." TechWeb News, August 21, 2003.

Fox, M. (2004) "FDA Encourages Radio Tags on Drug Bottles." Yahoo! News, November 15, 2004.

Frankel, M. (2005) Internal memo.

Gilbert, A. (2003) "MIT to Uncork Futuristic Bar Code." CNET News.com, August 29, 2003.

Godinez, V. (2005) "RFID Technology Going Mainstream as Ways to Use It Multiply." *Dallas Morning News*, February 23, 2005.

Guest, G. (2005) "Wal-Mart Likes High-Tech Tags; Retailer Says It Will Expand Test – New Devices Are Likely to Replace Bar Codes Eventually." *Seattle Times*, January 18, 2005.

Harris, G. (2004) "Tiny Antennas to Keep Tabs on U.S. Drugs." *New York Times*, November 15, 2004

Harris, R. (2003) "Library Wants to Put Chips in Books." Associated Press, October 3, 2003.

HighJump Software (2004) "The True Cost of Radio Frequency Identification (RFID)." HighJump Software: Eden Prairie, MN.

Hughlett, M. (2005) "Zebra's Tracking Raising the Bar; Labeling Leader Changing Its Stripes with RFID Printers." *Chicago Tribune*, February 24, 2005.

Humer, C. (2003) "Radio Tags Face Technical Hurdles, Deadline." Yahoo! News, November 2, 2003.

Jackson, R. H. (2005) "RFID Technology: Myths and Realities." *The Advertiser*, ANA, June, 2005.

Koppel, T. (2005) "Take My Privacy, Please!" *New York Times*, June 13, 2005.

Landt, J. and Catlin, B. (2001) "Shrouds of Time: The History of RFID." An AIM Publication. The Association for Automatic Identification and Data Capture Technologies: Pittsburgh, PA.

Lederer, B. (2003) "Consumer360 Refocuses AC Nielsen Plans." *Research Conference Report*, June, 2003.

Liard and Reinhardt (2003) "The RFID Overview: A Strategic Resource for Sellers and Users of Radio Frequency Identification Technology." Venture Development Corporation: Natick, MA.

Liard, M. J. (2005) "A White Paper on: The RFID Business Planning Service." Venture Development Corporation: Natick, MA.

McConochie, R. M. and Bailey, J.O. (2004) "Progress Toward Passive Measurement of Print." ARF/ESOMAR Week of Audience Measurement, Geneva (Switzerland).

McHugh, J. (2004) "Attention, Shoppers: You Can Now Speed Straight Through Checkout Lines." *Wired Magazine*, July, 2004.

Nairn, G. (2005) "Big Boys Dictate the Rate of Uptake." *Financial Times*, April 20, 2005.

Neff, J. (2003) "P & G Products to Wear Wire: Radio ID Chips on Shelves by 2008." *Advertising Age*, December 15, 2003.

Pethokoukis, J. M. (2005) "Big Box Meets Big Brother." *U.S. News & World Report*, January 24, 2005.

Rashid, F. Y. (2005a) "Symbol, Microsoft Team Up On RFID." Forbes.com, June 6, 2005.

Rashid, F. Y. (2005b) "The Great RFID Experiment That Wasn't." Forbes.com, July 22, 2005.

Shim, R. (2003) "Wal-Mart to Throw Its Weight Behind RFID." CNET News.com, June 5, 2003.

Sullivan, L. (2005) "Wal-Mart Assesses New Uses for RFID." *Information Week*, March 28, 2005.

Sweeney, P. J. (2005) *RFID for Dummies*. Wiley Publishing: Indianapolis, IN.

Swinand, M. (2005) "Next Exec: Tags are It." *Advertising Age*, March 21, 2005.

Want, R. (2004) "RFID: A Key to Automating Everything." *Scientific-American*, January, 2004.

TABLE 1
Effective Sample Sizes of 52-week Readership Panel, Relative to Current Sample Size of MRI Readership Survey in the US

	Publication Frequency	Intra-cluster correlation between readership in two random weeks	Design Effect	Ratio of Effective Sample Size for 52-week panel to current sample size	Minimum panel size for 52-week panel, as a percentage of current sample size
AARP The Magazine	Bi-Monthly	0.88	5.39	1.11	89.9%
American Legion	Monthly	0.87	10.54	1.14	87.8%
L. A. Times (Sun)	Weekly	0.83	43.10	1.21	82.9%
Sun Mag/Net Carr Nsp	Weekly	0.82	42.90	1.21	82.5%
Scouting	Bi-Monthly	0.75	4.76	1.26	79.3%
VFW Magazine	Monthly	0.76	9.41	1.27	78.5%
Guideposts	Monthly	0.76	9.35	1.28	77.9%
Arthritis Today	Bi-Monthly	0.70	4.51	1.33	75.2%
Ebony	Monthly	0.72	8.97	1.34	74.7%
Midwest Living	Bi-Monthly	0.69	4.47	1.34	74.4%
Game Informer	Monthly	0.72	8.91	1.35	74.3%
American Rifleman	Monthly	0.72	8.88	1.35	74.0%
Handguns	Bi-Monthly	0.69	4.44	1.35	74.0%
Endless Vacation	Bi-Monthly	0.69	4.43	1.35	73.8%
Diabetes Forecast	Monthly	0.71	8.85	1.36	73.8%
Nrth American Hunter	Bi-Monthly	0.68	4.40	1.36	73.4%
Playboy	Monthly	0.71	8.79	1.37	73.2%
Handy	Bi-Monthly	0.68	4.38	1.37	73.0%
Macworld	Monthly	0.70	8.72	1.38	72.7%
American Woodworker	Bi-Monthly	0.67	4.35	1.38	72.5%
Catholic Digest	Monthly	0.69	8.54	1.40	71.2%

Maxim	Monthly	0.68	8.52	1.41	71.0%
Sunset	Monthly	0.68	8.50	1.41	70.8%
Cigar Aficionado	Bi-Monthly	0.65	4.24	1.42	70.6%
FHM	Monthly	0.68	8.47	1.42	70.6%
FamilyFun	Monthly	0.67	8.40	1.43	70.0%
Texas Monthly	Monthly	0.67	8.32	1.44	69.3%
Ducks Unlimited	Bi-Monthly	0.63	4.15	1.45	69.1%
Tennis	Monthly	0.66	8.29	1.45	69.0%
Reader's Digest	Monthly	0.66	8.27	1.45	68.9%
Prevention	Monthly	0.66	8.25	1.45	68.7%
TV Guide	Weekly	0.68	35.74	1.46	68.7%
Runner's World	Monthly	0.66	8.24	1.46	68.7%
Real Simple	Monthly	0.66	8.21	1.46	68.4%
Cooking Light	Monthly	0.66	8.21	1.46	68.4%
Weight Watchers	Bi-Monthly	0.62	4.09	1.47	68.2%
Source, The	Monthly	0.65	8.18	1.47	68.2%
Essence	Monthly	0.65	8.17	1.47	68.1%
Workbench	Bi-Monthly	0.62	4.08	1.47	68.1%
PGA Tour Partners	Bi-Monthly	0.61	4.07	1.47	67.8%
American Baby	Monthly	0.65	8.12	1.48	67.7%
Official Xbox Mag	Monthly	0.64	8.09	1.48	67.5%
Coastal Living	Bi-Monthly	0.61	4.04	1.48	67.4%
Golf Digest	Monthly	0.64	8.08	1.48	67.4%
Sierra	Bi-Monthly	0.61	4.04	1.49	67.3%

TABLE 1 (Continued)

	Publication Frequency	Intra-cluster correlation between readership in two random weeks	Design Effect	Ratio of Effective Sample Size for 52-week panel to current sample size	Minimum panel size for 52-week panel, as a percentage of current sample size
Family Handyman	Monthly	0.64	8.05	1.49	67.1%
Penthouse	Monthly	0.64	8.05	1.49	67.1%
O, Oprah Magazine	Monthly	0.64	8.05	1.49	67.0%
Southern Living	Monthly	0.64	8.04	1.49	67.0%
Modern Bride	Bi-Monthly	0.60	4.00	1.50	66.7%
Kiplinger's Pers Fin	Monthly	0.64	7.99	1.50	66.6%
Truckin'	Monthly	0.63	7.97	1.50	66.5%
North Am. Fisherman	Bi-Monthly	0.59	3.97	1.51	66.2%
Nick Jr. Family Mag	Monthly	0.63	7.90	1.52	65.9%
Black Enterprise	Monthly	0.63	7.90	1.52	65.8%
Smithsonian	Monthly	0.62	7.86	1.53	65.5%
Jet	Weekly	0.65	33.98	1.53	65.3%
Schol Parent & Child	Bi-Monthly	0.58	3.92	1.53	65.3%
Golf Magazine	Monthly	0.62	7.83	1.53	65.2%
Stuff	Monthly	0.62	7.83	1.53	65.2%
Traditional Home	Bi-Monthly	0.58	3.91	1.54	65.1%
Better Homes & Gdns	Monthly	0.62	7.78	1.54	64.9%
Fit Pregnancy	Bi-Monthly	0.58	3.89	1.54	64.9%
Baby Talk	Monthly	0.62	7.78	1.54	64.8%
Woman's Day	triweekly	0.63	11.01	1.54	64.8%
Vibe	Monthly	0.62	7.77	1.54	64.8%
Super Chevy	Monthly	0.61	7.74	1.55	64.5%
Parent's Magazine	Monthly	0.61	7.74	1.55	64.5%
Bassmaster	Monthly	0.61	7.74	1.55	64.5%
Cosmopolitan	Monthly	0.61	7.73	1.55	64.4%

Guns & Ammo	Monthly	0.61	7.72	1.55	64.4%
Psychology Today	Bi-Monthly	0.57	3.86	1.55	64.3%
American Hunter	Monthly	0.61	7.72	1.55	64.3%
Stock Car Racing	Monthly	0.61	7.71	1.56	64.2%
Skiing	Bi-Monthly	0.57	3.85	1.56	64.2%
Consumer Reports	Monthly	0.61	7.68	1.56	64.0%
Family Circle	triweekly	0.62	10.86	1.57	63.9%
Scientific American	Monthly	0.61	7.67	1.57	63.9%
First For Women	triweekly	0.62	10.85	1.57	63.8%
National Geographic	Monthly	0.60	7.65	1.57	63.8%
Bon Appetit	Monthly	0.60	7.65	1.57	63.7%
Bride's	Bi-Monthly	0.56	3.82	1.57	63.7%
Good Housekeeping	Monthly	0.60	7.61	1.58	63.4%
Bridal Guide	Bi-Monthly	0.56	3.80	1.58	63.4%
Shape	Monthly	0.60	7.60	1.58	63.4%
PC World	Monthly	0.60	7.57	1.58	63.1%
Country Sampler	Bi-Monthly	0.56	3.78	1.59	63.1%
Hot Rod	Monthly	0.60	7.57	1.59	63.0%
Field & Stream	Monthly	0.59	7.53	1.59	62.7%
Ladies' Home Journal	Monthly	0.59	7.52	1.60	62.7%
Car And Driver	Monthly	0.59	7.52	1.60	62.7%
Parenting	Monthly	0.59	7.52	1.60	62.7%
PC Magazine	Bi-Monthly	0.55	3.76	1.60	62.6%

TABLE 1 (Continued)

	Publication Frequency	Intra-cluster correlation between readership in two random weeks	Design Effect	Ratio of Effective Sample Size for 52-week panel to current sample size	Minimum panel size for 52-week panel, as a percentage of current sample size
ESPN The Magazine	Biweekly	0.61	16.27	1.60	62.6%
W	Monthly	0.59	7.50	1.60	62.5%
GamePro	Monthly	0.59	7.47	1.61	62.2%
Ski	Bi-Monthly	0.55	3.73	1.61	62.2%
Street Rodder	Monthly	0.59	7.46	1.61	62.2%
Men's Health	Monthly	0.59	7.44	1.61	62.0%
Flying	Monthly	0.59	7.44	1.61	62.0%
PSM:Playstation 2	Monthly	0.59	7.44	1.61	62.0%
Metropolitan Home	Bi-Monthly	0.54	3.69	1.62	61.6%
Motor Trend	Monthly	0.58	7.36	1.63	61.3%
PC Gamer	Monthly	0.58	7.35	1.63	61.2%
Money	Monthly	0.58	7.34	1.64	61.2%
Yankee	Monthly	0.58	7.33	1.64	61.1%
Child	Monthly	0.58	7.33	1.64	61.1%
Martha Stewart Livng	Monthly	0.58	7.33	1.64	61.1%
Gourmet	Monthly	0.57	7.32	1.64	61.0%
Car Craft	Monthly	0.57	7.32	1.64	61.0%
This Old House	Monthly	0.57	7.32	1.64	61.0%
Seventeen	Monthly	0.57	7.30	1.64	60.8%
Electronic Game Mnth	Monthly	0.57	7.28	1.65	60.7%
Food & Wine	Monthly	0.57	7.26	1.65	60.5%
Country Living	Monthly	0.57	7.26	1.65	60.5%
Four Wheeler	Monthly	0.57	7.25	1.65	60.4%
Architectural Digest	Monthly	0.57	7.24	1.66	60.4%
Easyriders	Monthly	0.57	7.22	1.66	60.2%
Nat. Geo. Traveler	Bi-Monthly	0.52	3.61	1.66	60.2%
Conde Nast Traveler	Monthly	0.57	7.22	1.66	60.1%

Atlantic Monthly	Monthly	0.56	7.20	1.67	60.0%
Gardening How-To	Bi-Monthly	0.52	3.59	1.67	59.9%
Road & Track	Monthly	0.56	7.17	1.67	59.8%
Sat. Evening Post	Bi-Monthly	0.52	3.58	1.68	59.7%
Cycle World	Monthly	0.56	7.15	1.68	59.6%
4 Wheel & Off Road	Monthly	0.56	7.13	1.68	59.4%
Muscle & Fitness	Monthly	0.56	7.13	1.68	59.4%
Southern Accents	Bi-Monthly	0.51	3.56	1.68	59.4%
National Wildlife	Bi-Monthly	0.51	3.56	1.68	59.4%
Soap Opera Weekly	Weekly	0.58	30.83	1.69	59.3%
Glamour	Monthly	0.56	7.11	1.69	59.2%
Motorcyclist	Monthly	0.55	7.10	1.69	59.1%
Travel & Leisure	Monthly	0.55	7.08	1.69	59.0%
Wired	Monthly	0.55	7.05	1.70	58.8%
Men's Fitness	Monthly	0.55	7.05	1.70	58.8%
Self	Monthly	0.55	7.04	1.70	58.7%
CosmoGIRL!	Monthly	0.55	7.03	1.71	58.6%
American Photo	Bi-Monthly	0.50	3.51	1.71	58.6%
Salt Water Sportman	Monthly	0.55	7.01	1.71	58.4%
Hunting	Monthly	0.54	6.99	1.72	58.2%

TABLE 1 (Continued)

	Publication Frequency	Intra-cluster correlation between readership in two random weeks	Design Effect	Ratio of Effective Sample Size for 52-week panel to current sample size	Minimum panel size for 52-week panel, as a percentage of current sample size
Fitness	Monthly	0.54	6.98	1.72	58.2%
In Style Mag	Monthly	0.54	6.97	1.72	58.1%
Country Home	Monthly	0.54	6.93	1.73	57.7%
Popular Science	Monthly	0.54	6.93	1.73	57.7%
Redbook	Monthly	0.54	6.91	1.74	57.6%
Smart Money	Monthly	0.54	6.90	1.74	57.5%
Teen People	Monthly	0.54	6.90	1.74	57.5%
Off US Playstation	Monthly	0.53	6.88	1.74	57.3%
Popular Photo & Imag	Monthly	0.53	6.85	1.75	57.1%
Outdoor Life	Monthly	0.53	6.85	1.75	57.1%
Elle Decor	Bi-Monthly	0.48	3.42	1.76	57.0%
Game & Fish	Monthly	0.53	6.79	1.77	56.6%
Inc.	Monthly	0.53	6.78	1.77	56.5%
Entrepreneur	Monthly	0.52	6.77	1.77	56.5%
Country Weekly	Biweekly	0.55	14.66	1.77	56.4%
Soap Opera Digest	Weekly	0.55	29.26	1.78	56.3%
Outside	Monthly	0.52	6.73	1.78	56.1%
Bicycling	Monthly	0.52	6.73	1.78	56.1%
Spin	Monthly	0.52	6.73	1.78	56.1%
Premiere	Monthly	0.52	6.72	1.78	56.0%
GQ (Gent's Qtrly)	Monthly	0.52	6.71	1.79	55.9%
Computer Shopper	Monthly	0.52	6.68	1.80	55.7%
Yachting	Monthly	0.52	6.67	1.80	55.6%
Popular Hot Rodding	Monthly	0.51	6.64	1.81	55.4%
Popular Mechanics	Monthly	0.51	6.62	1.81	55.1%
Elle	Monthly	0.51	6.61	1.81	55.1%
Working Mother	Monthly	0.51	6.60	1.82	55.0%
House Beautiful	Monthly	0.51	6.60	1.82	55.0%
Jane	Monthly	0.51	6.59	1.82	54.9%

Boating	Monthly	0.50	6.55	1.83	54.6%
Discover	Monthly	0.50	6.52	1.84	54.3%
Vogue	Monthly	0.50	6.50	1.85	54.2%
Star	Weekly	0.53	27.95	1.86	53.7%
Rolling Stone	Biweekly	0.51	13.76	1.89	52.9%
House & Garden	Monthly	0.49	6.34	1.89	52.8%
Marie Claire	Monthly	0.48	6.33	1.90	52.8%
Sport Truck	Monthly	0.48	6.33	1.90	52.7%
Health	Monthly	0.48	6.27	1.92	52.2%
Photographic	Monthly	0.48	6.26	1.92	52.1%
Woman's World	Weekly	0.51	27.02	1.92	52.0%
Vanity Fair	Monthly	0.47	6.22	1.93	51.9%
Barron's	Weekly	0.51	26.92	1.93	51.8%
Forbes	Biweekly	0.50	13.46	1.93	51.8%
Men's Journal	Monthly	0.47	6.18	1.94	51.5%
Sporting News	Weekly	0.50	26.75	1.94	51.4%
National Enquirer	Weekly	0.50	26.71	1.95	51.4%
Wine Spectator	Biweekly	0.49	13.30	1.95	51.2%
Automobile	Monthly	0.47	6.12	1.96	51.0%

TABLE 1 (Continued)

	Publication Frequency	Intra-cluster correlation between readership in two random weeks	Design Effect	Ratio of Effective Sample Size for 52-week panel to current sample size	Minimum panel size for 52-week panel, as a percentage of current sample size
Sports Illustrated	Weekly	0.50	26.47	1.96	50.9%
Allure	Monthly	0.46	6.08	1.98	50.6%
Natural History	Monthly	0.46	6.03	1.99	50.3%
Home	Monthly	0.45	6.00	2.00	50.0%
Esquire	Monthly	0.45	5.99	2.00	49.9%
New Yorker, The	Weekly	0.48	25.58	2.03	49.2%
Fortune	Biweekly	0.47	12.74	2.04	49.0%
Motor Boating	Monthly	0.44	5.82	2.06	48.5%
Hemispheres (United)	Monthly	0.44	5.80	2.07	48.3%
New York Magazine	Weekly	0.47	24.74	2.10	47.6%
Newsweek	Weekly	0.46	24.29	2.14	46.7%
Business Week	Weekly	0.45	24.03	2.16	46.2%
Time	Weekly	0.45	23.86	2.18	45.9%
Us Weekly	Weekly	0.45	23.83	2.18	45.8%
Town & Country	Monthly	0.41	5.49	2.19	45.7%
People	Weekly	0.44	23.69	2.19	45.6%
Entertainment Weekly	Weekly	0.44	23.36	2.23	44.9%
Harper's Bazaar	Monthly	0.40	5.38	2.23	44.9%
US News & World Rpt.	Weekly	0.43	22.78	2.28	43.8%
Autoweek	Weekly	0.42	22.20	2.34	42.7%
Attache	Monthly	0.36	4.97	2.42	41.4%
Southwest Spirit	Monthly	0.33	4.67	2.57	38.9%
Northwest Wrld Trav.	Monthly	0.33	4.61	2.60	38.4%
Delta's SKY Magazine	Monthly	0.32	4.48	2.68	37.3%
Sports Weekly	Weekly	0.35	19.04	2.73	36.6%
Continental	Monthly	0.31	4.36	2.75	36.4%
American Way	Biweekly	0.26	7.58	3.43	29.1%

Source: Frankel, Internal memo, using 2004 Fall Mediamark Research Inc. weighted to Population - Base: All

Appendix

Photos of Passive RFID Tags

Photo #1

Source: www.rfid-101.com

Photo #2

Source: www.library.com.tw/

Photo #3

Source: **www.moeller-horcher.de**