Printing in the Third Dimension

By William Lumpkins

With fall in the air, children heading back to school, and life returning to a constant rhythm, it has been a busy year in the world of standards. I had the opportunity to speak at the 2013 IEEE International Conference on Radio-Frequency Identification (RFID) Technologies and Applications held in Johor, Malaysia, on the future of energy harvesting. Energy harvesting systems use digital signal processing with adaptive phase-changing antennas to recapture electromagnetic energy from the surrounding environment, extending their products' battery life by 30–40% using trickle power recharging.

IEEE P1874 has completed its balloting pool acceptance period and is in its balloting process. If all goes well, it will be a completed standard by the end of the year. In conjunction with the completion of the IEEE P1874 standard is the start of the development of the IEEE 1874 compliance tool as well as the IEEE 1874 certification program. The certification program is currently being bid on by the IEEE conformance and compliance team as well as other standard development organizations. P1874 is a small but integral part of a host of environmentally conscious standards developed by the IEEE Consumer Electronics (CE) Society and the Environmental Assessment Standards Committee of the IEEE Computer Society. The P1874 *Standard for Documentation Schema for Repair of Electronic Devices* details how to conform to a standardized format for display of user manuals and repair manuals that will be used on XML-based display devices such as Apple's iPad, Amazon's Kindle Fire HD, or the bevy of smart phones that are an integral part of our new collective social interactive ecosystem.

Currently, IEEE P1874 is being referenced in Underwriters Laboratories (UL) 110, which is the *Standard for Sustainability for Mobile Phones*. The development of P1874 was initiated by Kyle Wiens, the cofounder of iFixit, as well as members of O'Reilley Publishing (makezine.com), producers of the ever popular *Make Magazine* (Figure 1) and the eclectic Maker Faire, which is held throughout the world. With the eventual conclusion of the P1874 standard, the IEEE CE Society has formed a study group to create a standard for the interoperability of three-dimensional (3-D) printer systems.

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FIGURE 1. *Make Magazine*. (Source: O'Reilly Publishing.)

WHAT IS A 3-D PRINTER?

Three-dimensional printers, shown in Figure 2, generally use a plastic polymer or other semifluid material that hardens after a cooling or a curing process. The 3-D printer uses a computer-assisted design (CAD) file such as a stereo-lithography (STL) or "Step" file (in the hacker

FIGURE 2. Stratasys's Fortus 360mc 3-D production system. (Source: Stratasys Inc.)

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FIGURE 3. The AR-15 assault rifle. (Source: Joe Cereghino.)

community, these files are generally called "physables"), or it can also use traditional AutoCAD or SolidWorks files. The 3-D printer then prints the design from the base up, layer by layer. The following link contains an interesting video of the Stratayas Mojo software system: www.tekprogroup.com/prototype_mfg_015.htm.

This printing process can take between 15 min to a few hours or a few days depending on the complexity, size, and density of the design. This allows quick-turn prototypes of cases or industrial designs of product bodies, thus foregoing the costly tooling charges associated with testing out a proof of concept for a new consumer product. This type of printing also allows for the creation of intricately designed machined parts that can be used in semi-harsh environments, such as a remote-controlled vehicle or an Armalite (AR)-15 rifle (Figure 3). You can see the CNBC interview with the leader in the 3-D printing of AR-15s at www.youtube.com/watch?v=NX3bMvYkGRc.

As can be seen, the 3-D printing space has taken off from the back rooms of hackers, scientists, and inventors to the high-end hobbyist. While traditionally, 3-D printers cost US$30,000–40,000, today hobbyist 3-D models can be purchased for only US$2,000–3,000, which is still a bit pricey for me. The company MakerBot in Brooklyn, New York (Figure 4), recently made news by being acquired by the much larger 3-D printer company Stratasys Ltd. for US$403 million. These acquisitions are creating a smaller ecosystem, but they allow smaller companies such as Printrbot LLC, founded by CEO Brook Drumm, to enter the market with a severely price-reduced 3-D printer for just US$649, which is a serious alternative to the big players in the 3-D industry.

Printrbot is an example of a Kickstarter success story (see www.kickstarter.com). As many of you know, Kickstarter allows innovators, hobbyists, and others to present their ideas to the masses and allows them to contribute financially to the development of the project. For example, Brook Drumm's goal was to raise US$25,000 for his Printrbot project, but through Kickstarter, he was able to raise more than US$830,000. As this far exceeded his goal, he has been able to further reduce the overall cost of his project, and now his vision is to create ultra-low-cost 3-D printers (Figure 5) that eventually every school child will be able to access for assistance with school science project, and extra-curricular activities (see www.kickstarter.com/projects/printrbot/printrbot-your-first-3d-printer).

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While major players such as Google Ventures, Intel Capital, and Goldman Sachs Angel funds investigate the possible purchase and/or investment in these types of companies, individuals are using their creative skills to create physables of unique product components. This brings up an interesting legal dilemma; a person may patent a product or have an idea of a product, but how is the distribution or the tracking of a physable covered? Can the physable, a software file that can be used

FIGURE 4. MakerBot's Replicator 2 desktop 3-D printer. (Source: Stratasys Inc.)

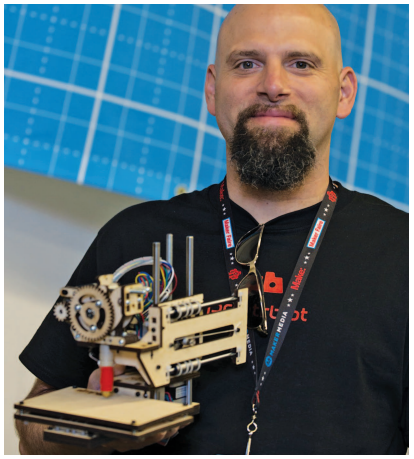

FIGURE 5. Brook Drumm, CEO and founder of Printrbot LLC, is holding a prototype of his latest vision, a US$299 portable 3-D printer. (Source: Andrew Terranova, *Make Magazine*.)

to create a patentable product type or a component of a product, which may be covered by a patent, be controlled in its software form? The physable does not violate any patents in my humble opinion. It is not until the physable is used with a 3-D printer, and possibly only when the end developer tries to sell the product, that it is possibly in violation of a patent. What about the creation of the physable itself? Web sites such as The Pirate Bay (www.thepiratebay.se) are actively trading these software files just as they are actively trading other patentable content, such as movies, e-books, and music. This trading occurs irrespective of the physable owners' rights. Whether or not physables should be treated as copyrighted or patented material is outside the realm of us lowly engineers. Our main concern is that, when these files are used with 3-D printers, they should interoperate with the future generations of this disruptive technology.

The IEEE CE Society Study Group on Standards for 3-D Printing Technology will focus on these issues from a technical and interoperability standpoint. If you are interested in participating, please contact me at xillia@ieee.org.

ABOUT THE AUTHOR

William Lumpkins is the lead technical consultant for Wi2Wi, Inc. He is also a Senior Member of the IEEE and the IEEE Consumer Electronics Society Standards Committee chair.