According to the Gartner Group’s “Hype Cycle” there are five distinct stages through which emerging technologies develop.

• **Technology trigger.** A public breakthrough or other event generates significant press and industry interest.
• **Peak of inflated expectations.** Massive publicity generates wild enthusiasm and euphoric projections although technical and business failure is more common than success.

• **Trough of disillusionment.** Overinflated technology expectations cause the publicity bubble to burst.

• **Slope of enlightenment.** Basic applied research by a growing number of organizations develops a true cost/benefit understanding. Off-the-shelf applications allow wider industry penetration.

• **Plateau of productivity.** Technology benefits become established as related products become more stable, robust and cost-effective.

Today, all of these stages can be used to describe different aspects of radio frequency identification (RFID).

**RFID Overview.** All RFID systems must contain three components. An antenna emits radio signals to activate the RFID tag and to read and write data to it. The transceiver and decoder control the system’s data acquisition and communication. The antenna, transceiver, and decoder can be combined into a single unit and is commonly referred to as a reader or interrogator.

A transponder or RF tag is electronically programmed with unique information. The reader emits radio waves that vary depending upon its power output and the radio frequency used. When an RF tag passes through such an electromagnetic zone, it communicates with the reader’s signal. The reader then collects and decodes the data encoded in the tag’s integrated circuit, and this data is passed on for processing.

RFID tags come in a wide variety of shapes and sizes. Tags permanently affixed to expensive assets (i.e., containers) can justify a greater expense than those affixed to relatively unimportant items. Tags can be either passive or active.

• Passive tags have no power source of their own and rely on the reader’s signal to be activated. Passive tags are lighter, less expensive, and last longer than active tags, but they have shorter read ranges and require a higher-powered reader. Read-only tags are mostly passive and are programmed with a small set of unique data that cannot be modified in the field.

• Active tags are powered by an internal battery and can typically read and write data on demand. Battery-supplied power of an active tag often gives it a longer read range. The tradeoffs are greater size, greater cost, and limited operational life. However, new technologies are constantly shrinking battery size and power needs.

RFID systems are also distinguished by their frequency ranges. In general, for a given power output, low-frequency (30 KHz to 500 KHz) systems have longer read ranges and lower system costs, while high-frequency (850 MHz to 950 MHz and 2.4 GHz to 2.5 GHz) systems offer higher reading speeds, shorter read ranges, and are more expense.

Once an RFID system is setup, there are still technical issues that need to be resolved:

• Incompatible standards are an issue, but not a big problem in the RFID industry since most readers are not very expensive and some are quite versatile.

• Security of RFID tag data is a problem. Consider the implication of any third party knowing the contents of a smart tagged container down to the SKU level.

• Addressing security concerns through encryption potentially creates process inefficiencies along the supply chain and may also be considered a barrier to competition.

**RFID Challenges.** When considering an RFID project, it is necessary to analyze the entire process. For example, a great deal of attention has been focused on the cost of an individual RF tag. However, in many cases, the initial tag costs is not the major hurdle. Physically tagging items can be quite expensive. For example, tagging chassis in a metropolitan area...
requires getting access to each chassis at a place and time appropriate for a tag to be attached. Testing, maintenance, and replacement of tags require an even larger logistics effort and expense.

It is also necessary to consider technology limitations. Automatic Equipment Identification (AEI) technology applied by railroads for identification of locomotives and railcars is a good example.

• AEI is not 100 percent accurate. It is a good tool, but it is not perfect.
• AEI works best along single tracks where there is no chance of spurious readings from cars on adjacent tracks. Certain mainline and yard choke points are good locations for AEI readers.
• Ironically, where AEI performs best (mainlines), it is least needed, because other systems and existing business practices keep good track of consists, documents that show the order of the train, the locomotives and cars and their destination and other information. Consist accuracy on the main lines has always been good.
• On the other hand, consist accuracy in yards has always been a big problem. Furthermore, getting clean reads in a crowded classification yards is difficult.

AEI cannot provide complete information. Despite claims by some vendors, it is a computational challenge to know where cars are located within a yard just by examining streams of passing data from multiple readers. Some believe that active tags combined with GPS systems will enable tags to track literally all over the world. However, the costs of such systems limit their use to specialized applications.

Business Limitations. Technology can do lots of flashy things, but the bottom line will always be fulfillment of your business case. The issue in front of management — how does an organization realize its business case benefits — still depends on getting tag data to the right people, at the right time, and in the right format.

All business cases have a bottom line. Projects with a sufficiently favorable bottom line are often funded. Yet, few business cases in either the public or private sectors are revisited in detail after funding is approved. This practice leaves the initial objectives and motivation to do a project disconnected from ongoing project management, and thus, the final results of the project. Technology projects are notorious for promising tremendous bottom-line business cases, only to either fail out right or to deliver anemic results.

The reasons a particular technology may physically fail are many, but even when a project functions properly from a technical perspective, its underlying business case may not be met. In other words, getting to the bottom line of a business case requires much more than functioning technology. Keeping business practices aligned to make use of better data and prescriptive output from support systems is critical to project success. Disconnects in business practices within an organization often nullify a project’s potential benefits.

Providing great data or prescriptive output is meaningless if the information is not acted upon.

Multiple technologies are required to get raw RFID data to where it can be utilized. These supporting technologies include LANs, WANs, RF connectivity, host systems, relational databases, decision support systems, etc. Unfortunately, these technological components are aligned in series. That is, if any one of them does not work properly, the project fails. RFID will not work if the tag or reader are broken, if the WAN is down, or the database is not functioning properly. Field equipment must be tested regularly (both readers and tags). In addition, certain components required for success, such as decision support systems, may not yet be deployed or even available. Note that lack of data accuracy is often blamed for the underlying problem of lack of procedural discipline.

Several questions management should ask prior to embarking on an RFID project are:
How do you get RFID generated data to the right people? What applications do they use and how will the RFID data be incorporated?

How do you make the RFID data digestible for end users? Do you show them every read, or do you need to summarize or graph the data?

Will end users trust the RFID data?

How will end users make use of the improved RFID data accuracy? Will they ignore it, or will they be capable of incorporating it into their daily activities and decision-making processes?

Note that RFID data does not directly improve operations, but merely improves data integrity at the site of the reader. Getting from an improvement in data quality to a hard cost savings or improvement in customer services requires expert end users, enlightened management, and additional technologies such as a sophisticated decision support system (DSS). Even then, it might still not be enough. Tagging a chassis can ensure that you recognize the initial and number — but it may not let the terminal know who the chassis sublessor is or what to do with the equipment. Again, providing great RFID data and any prescriptive solutions is meaningless if they are not acted upon.

Sustainment of all technology and infrastructure, including software support, hardware maintenance, and, most importantly, continuous end-user and management training, is critical if an organization wants to hold onto any benefits derived from a technology project. Deploying a sophisticated DSS requires the political and financial alignment of many individuals from many departments throughout an organization. Will rank-and-file members or even management trust or embrace a new system or data feed if it threatens their job security or is associated with considerable cost reductions?

The multiple constituencies requiring alignment include rank-and-file workers and various levels of management across multiple departments and locations. Similar alignment is also required with all stakeholders including vendors, customers, and government agencies. Will all departments, vendors, and customers be able to access and share the benefits of the RFID data?

Organizational follow-through is critical to garner bottom-line cost savings or improved customer service or revenue increases. Therefore, senior management has the task and responsibility to see that proper alignment and follow through takes place across not only their organization, but also across the industry.

**Conclusion.** RFID is a very good peripheral device in the design of a comprehensive solution to visibility management. Other components include sophisticated decision support systems, flat organizational structure, and procedural discipline. The following is a list of success factors for RFID technology projects.

- RFID hardware and technology must work and be highly reliable.
- Reads must be clean (free of spurious data).
- RFID data must be transferred in a timely fashion via LAN, WAN, etc. to a well-structured, efficient, and accessible database.
- Decision support systems (DSS) must be comprehensive and present all relevant data (including RFID data) in an easy to digest format to the right end users at the right time.
- Administrative structures and an organization’s culture must allow informed decisions to be effectively executed based on the output of a DSS.
- Data (including RFID data) and prescriptive results must be appropriately shared across organizations (including vendor and customer groups) in order to benefit all parties.
- All components must be maintained, supported, and enhanced as requirements continue to evolve. This includes the significant task of end-user and management training and
retraining.

Knowing exactly what something is and where it is located right now is very valuable, but this information alone does not immediately improve one’s logistics operations. Organizations need all the other pieces of the puzzle outlined throughout this article (not just a sophisticated peripheral device) to get to the bottom line of their business case.

Thomas A. Feo is president and co-founder, and Theodore Prince is senior vice president for marketing and sales of Optimization Alternatives Ltd. Inc., an Austin, Texas-based company that develops and deploys large-scale control and decision support systems to manage freight transportation.

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