

The Math Behind RFID in Logistics

There is a good business case for using RFID to track containers and chassis.

Jan. 31, 2005—RFID is a hot technology. Metro, Target, Tesco and Wal-Mart are deploying it, and every magazine on earth seems to be writing about it. There are promises that it will transform manufacturing, retailing and the supply chain. But is there a business case for using RFID to track ocean containers and containers chassis, the undercarriage with wheels used to transport containers.

In one recent study, 62 percent of transport and logistics providers said that the business case for RFID is not strong enough for their companies to deploy the technology today. Results from the same study, which was commissioned by [eyefortransport](#), an online publisher of logistics and transportation information and news, indicate that 53 percent believe that "currently installed technology gives us all the efficiency, accuracy and visibility we need."

It's surprising that logistics providers feel the business case isn't there for using RFID today to track containers and chassis, but it was strong enough a decade ago for the railroad industry to adopt it, given that the railroads have a lot fewer places to lose cars than logistics providers have for losing containers. For the railroads, RFID is old news; they have fortified RFID with even more advanced technologies, including GPS, real-time engine-health monitoring and wireless data communication.

Why can't logistics providers find a business case for using RFID to track containers and chassis? If better container-tracking information were available, couldn't carriers decrease fleet sizes, increase utilization and lower costs? Sure. But the benefits of tagging containers, installing reader infrastructure and building systems to use the data depend on widespread adoption. No carrier wants to go first, bear the cost and put itself at a cost disadvantage.

But there are benefits from tagging equipment today. The savings accrue when you know for certain what assets you have and where they are at every hour. Then you can whittle away at the number of containers and chassis you need to accommodate reasonable customer demand. Suppose you can reduce your empty-equipment inventory and push utilization from 50 percent to 60 percent. Wouldn't you save a pocketful of money? In the case of a chassis, an increase in annual utilization from 50 percent to 60 percent is a reduction in cost of 35 days, or about \$300 per year. You can buy a lot of RFID tags and computer systems for \$300 per chassis.

The determination of optimal equipment fleet size is a twist on the standard inventory-control problem described in university business classes. In other industries, one solves the problem to determine the "economic order quantity"-- the order quantity that minimizes total inventory costs. In logistics, we solve the problem for total fleet size. The objective is the same: to determine the point at which the total cost of operating the fleet plus the cost of stock-outs (lost-business and equipment-repositioning costs) is minimized.

To do the math, we need four types of information:

* Historical data describing use of the fleet

- * Current data describing each piece of equipment in the fleet, and the availability and location of each of those pieces
- * Projected dates of return of equipment currently in the possession of customers
- * The cost of not having a required piece of equipment

RFID adds significant value to the data in the first two categories. It increases substantially the accuracy of current location data. If you know for sure that you have equipment of a particular size and type in the yard, you can confidently take bookings and expect to make deliveries against bills of lading. When RFID surveillance is extended to rail and customer facilities, you can make certain assumptions about the near-term availability of equipment, even though it is not yet returned to general availability. When this focused information is retained in a useful database, the fleet operator, through its software systems, can start generating information in greater and greater detail. Just a few years ago, it was possible to determine only the average time a chassis was in the community (time from out-gate back to in-gate). Now it is possible to extract the same information by terminal, customer, trucker, equipment type and even by day of the week.

The missing piece, and one that RFID alone will not provide, is a view of the future. In the same way that automobile rental companies are crucially interested in the time you say you will return their car, logistics providers should seek to get from their trucker, shipper, broker and rail partners an estimate of the time and date of equipment return to the terminal. Historical data is one way to generate estimates. Appointment systems are another way to gather this information. In the long run, fleet operators will need to provide an incentive (economic or otherwise) for their partners to make accurate estimates of delivery time and tender this information to the operator. To the extent that operators collect RFID information that is valuable to their partners and deliver it to those partners, the partners can be induced to make similar information available back to the ocean carrier and terminal operators. This is a win-win proposition. Of course, it requires rather more widespread acceptance, so that partners' investments in RFID will work with most or all of their ocean carrier and terminal partners.

The math also requires an assumption about the cost of a stock-out. As you decrease fleet size, you will inevitably end up with more situations where you run out of chassis or containers. It's not the end of the world, although sales people and customers will complain. You simply need to assign a cost to the event. The granularity with which you do that is a matter for the analysis team. Lack of a sufficient number of refrigerated cars is more serious than the lack of dry boxes. Dry boxes you can lease from a pool. Reefers represent more revenue, cost and pretrip maintenance.

When a customer needs a chassis and there isn't one, what's the cost? An accountant will tell you that the opportunity cost is the forgone profit from the move the customer would have made. The line manager will complain that the carrier lost all the revenue from the move. And the sales guy might tell you that not having equipment available will cost the entire account. The three possibilities might be the loss of \$100 in margin, \$1,000 in container revenue, or \$ 1 million from loss of the account. The ocean carrier should determine the commercial approach. The mathematical approach is the same.

My company estimates the costs to add RFID tags to a world fleet of 16 million containers to be about \$480 million. Our estimate to equip 5,000 facilities with 50,000 RFID readers is \$200 million. One analysis we did of such an investment showed a positive ROI on all costs, capital and ongoing, with an increase in equipment utilization of just 0.6 percent. The average container introduced to service in 2003 costs \$1,800. A tag will add only \$30. If the world had a centrally planned economy, the decision would be a slam-dunk. Just do it. But these decisions need to be made by individual firms. Those decisions need to be based on analysis. Each firm will likely come to a similar conclusion: RFID is a good choice—if my competitors and partners do it too. Otherwise, I won't be able to count on every interchanged container being tagged or that there will be sufficient readers outside my own organization's facilities.

OK, so now you've designed the decision-support model to help you decrease the fleet size. It will predict where and when you need equipment. You recognize the cost of whittling too much of your container and chassis inventory. You have quotes from vendors to install an RFID system. You are reasonably assured that the RFID units you buy will be industry compatible. Now the question is, When to pull the trigger? You know that if you are an early adopter, you will gain some benefit, but the costs will likely outweigh the benefits. Only if there's widespread industry acceptance can you count on positive benefits from installation of RFID. Now is when you make a guess at what your competitors will do. If no one is talking through a conference agreement or international standards body, you have to count on every player doing what makes the most sense for itself only.

Game theory—a branch of mathematics that uses models to study interactions with formalized incentives or rewards—explains exactly the position we're in. There are two Nash equilibriums for the RFID game. (Remember John Nash, the disturbed mathematician in *A Beautiful Mind*? In game theory, if a situation has the property that no player can benefit by being the only one to change his strategy, the corresponding set of payoffs constitutes a Nash equilibrium.) One equilibrium occurs when the whole logistics industry adopts RFID. No player can better his position by opting out of RFID. The other Nash equilibrium occurs in the situation we have today, when no one adopts RFID. No player can better his position by adopting RFID alone. The only way to move from one equilibrium to another is to organize an agreement or consortium between the players to get some of them to adopt. That's called a salient.

The good news is that there is some movement in just this area. The U.S. Department of Homeland Security continues to talk about "smart containers," which implies RFID. The terminal operators in Southern California have agreed to adopt RFID for all tractors in the region. Once the RFID reader infrastructure is in place, containers and chassis can be tagged at a low marginal cost. In December, an ISO committee met in Beijing to reaffirm the standards for container, chassis and seal tagging. It looks like ISO will reconfirm the standards for passive chassis and container tags ("container license plates") in the ultra-high frequency band, and add an international standard for active tag container seals in the 433 MHz range.

The game changes as soon as one early adopter announces its intent to pursue container tagging. At that point, we move from an equilibrium condition to a situation in which it is beneficial for all others to follow. With an international standard to build from, it simply remains for the first few carriers to make a move. It is easy to conclude that the industry will soon follow, adopting RFID.

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