ROBERT CLARKE: My name is Rob Clarke. I'm from Michigan State University School of Packaging. And I've been doing RFID research since 1999. We just are in the process of finalizing purchase of a 10,000 square foot facility to move a new lab that'll look at both active and passive. But moving forward with this whole session now-- a couple of things that kind of bothered me about this.

I keep walking in and on the bulletin boards right outside the door there is a big advertisement for Urinetown, and I want to know who leaked information about this session. OK. From a packaging standpoint, how many people here are directly involved with packaging? OK. A few. You may or may not know Jim Goff-- the name-- who founded the packaging discipline at Michigan State University-- the first academic packaging facility in the world.

He just passed away last week. And it's a very unfortunate situation. And for those of you that didn't know, on the news this morning, Super Value just purchased Albertsons. And we don't know what that's going to do to their RFID announcements. But I also want to thank the sound guy up there because he's been working his tail off for this entire conference. And the rest you'll wait for.

Special thanks to Steve Miles and the MIT crew, the conference committee for all the work and phone calls that we had back and forth, all the speakers, and of course, all the attendees because without the interchange of our ideas and your input this wouldn't move very far. And we can all say that we're part of the soakers club now due to our walk yesterday crossing the puddles on the way there. We're bound for life.

Why study packaging? What does packaging have to do with "riff-id" or "arr-fid" or anything else. Well, Throckmorton P. Ruddygore III, one of my favorite people once stated, packaging is a center of the universe. You might as well accept it now. All these other disciplines and fields just support packaging. And once you come to that agreement, you'll see why packaging is relevant to RFID.

Our work is a ground-level, hands-on approach. A lot of the information that I hear is the 30,000 foot overview, which is wonderful. It sets direction. It sets precedence. And it doesn't mean shit if it doesn't work. You have to have the ground-level, hands-on approach to make sure it works. That's what packaging does.

Now, why is this so? What is packaging? Real quickly. You're all going to be experts in 30 seconds or so. There are different levels of packaging. Primary, secondary, tertiary, all the way up through unitized loads or cargo container loads, however you want to look at it. Primary physically holds the product. A bottle is a primary container.

Secondary container-- we're really brilliant-- holds primary containers. So a six pack of your favorite amber beverages would be a secondary container. Tertiary-- I bet you're getting this now-- holds the secondary. So a shipping case would be the tertiary, and on and on and on.

Not all products have the same levels or requirements. You also have different requirements for different industries. You have the consumer sector, which we've heard a great deal about. Retail outlets, these types of things. Industrial sector really hasn't gotten a lot of play here except some of the DHL and larger volumes, but it's a huge market.

When you think of all the trucks you see driving down the highways with the big boxes of materials or machinery, that's a sector that is completely ignored. Military-- think about packaging something that you don't know when it's going to be used, where it's going to be used, or what the evaluation is for once it is in use somewhere between now and 20 years from now. How do you package that? Real interesting dichotomy.

And then, of course, medical pharmaceuticals, which we've heard a great deal about. How many of you want your packaging to fail prior to taking your medicine? Huge implications. And what goes on for powdered soap for Mr. Procter & Gamble, Cascade-- you brought that up earlier-- is a little different than what goes on for a life-saving medicine, and there are different requirements.

So packaging has to address those. It then has to do all of that with an eye towards cost. And for 10 seconds, cost and price are not equal, period. You don't talk about the aversion to moving into RFID because of the cost. It's actually the price that most people-- if they look at the cost, you have insurance costs, liability costs, opportunity costs, goodwill costs. And you have to balance the costs, positive and negative, before you can make a business case. And that's more of the business side coming out.

Price is what you pay for something. Environmental issues. Simply put, your product plus your package, at worst, has to equal the environment that you're going to ship it through. Now, you know everything you need to know about packaging, pretty much. If a package doesn't do its job in that environment, it breaks down, product spills or breaks. No good. If it's too good and your product all gets there in perfect shape, you're losing money. So there's a fine balance and trade off there that you have to look at.

Four main functions of packaging, any one of which can be considered a package by itself, but ideally, most of the packages we're talking about have all four. Containment. Physical holding. You'll see my little no sign up there. Why? Because the containment function of packaging really doesn't mean anything with respect to RFID implementation.

Convenience and utility. Easy opening features. Reclosability. Secondary uses. These types of things in packages. Maybe, maybe not have an opportunity with RF. If you're looking at material sorting in a recycling center, maybe. That's a possibility.

Now, communication and protection. A package should communicate to the users how to open it, how to close it, safety. Don't try ripping the damn plastic clam shells apart with your hands because you'll cut your fingers up. That's the number 1 hated package in the world. It doesn't matter what country you're from. People hate it.

But protection is a really key one for almost every package system. You have to protect the contents from the environment, be it a physical environment, shock, vibration, compression, during distribution and handling. Be it environmental and temperature, humidity. Salt spray. We had conference, too. These types of things.

You also in many cases need a package to protect the environment from the product. Nuclear waste. How many of you want those packages to fall apart and leak, say, any time within the next 20,000 years? So these are functions of packaging that you need to take into account.

The impact of this? It's cool. Everything has to be packaged. It's the center of the universe. You can go into any field you want through packaging, and students like that. All companies and industry use it at some level. And it should withstand the rigors of distribution, manual and mechanical handlings, warehousing and storage, not create any problems, and give the ultimate user a sense of value.

What is value in this case? You ask somebody, what is it that you want? And then you give it to them. And if you really want customer satisfaction, give them something extra. What a bargain. What a value. Package and can do this.

Now, at the MSU School of Packaging, we focus on RFID applications for the supply chain because the item level is a great marketing thing, but it's a ways off. Supply chain has some real applications. You're using bulk quantities. You have fixed points that you're using, although they're nebulous depending on the company and everything else. And you want to ultimately define the perfect purchase order so when a store or customer orders a product or a truckload of products, they get exactly what they want, when they want it, in the right count. And that's one of the things RFID can do.

Little aside-- MSU School of Packaging, we have 600 undergraduates. We have just about 100 master students and 20 PhDs. Who'd have thunk packaging would be that big all in our own school? Now, we haven't spent a lot of time talking about active packaging a little bit yesterday, but there is a real opportunity for complementary active and passive application. If you start down here with item levels, going into a case, going into a pallet, ultimately going into a container, you can track those.

And if you note, some of those require passive tags, meaning the tags don't have any internal energy source. They collect it from the readers at read points. Versus an active tag, which may go on the container. And you'll see if you look in the bottom corner, I stole this from the Department of Defense because this is how they ship things over to the Middle East for the Iraqi and Afghanistan or wherever the hell they are over there. Pakistan having problems.

And I like it because it shows that you have different responsibilities at different parts of the supply chain. And there's a lot more to this, but I want you to realize that because here's the key. There's nothing that says some of those applications have to be RFID. I love RFID. I live and breathe RFID.

But it's just a technology. And there are a lot of different frequencies and applications, some of which are better suited by other technologies. There are different frequencies than 9:15. I think the opportunities presented by EPC for bringing a lot of positive things to the world is a strong, well-defined, forward-thinking process. But it's not the only RFID process out there.

They cover 13.56, 9.15. Those are key elements. But there's a lot of other applications that don't use those frequencies, that don't use the same type of applications, and we will have to be careful not to exclude those and focus only on certain areas.

Now, why look to a university? Well, I made this one up because it looks cool. And of course, packaging's in the center of that universe, as we all know it should be by now. But we interact with users, we interact with institutional players, and we interact with suppliers. We have nothing to sell except our work and our research. And if we don't do a good job, we don't sell it very well. So these are some of the areas that I would encourage you to look at, think about, and if it makes sense for you to develop some of the work with the university, hey. We encourage it.

Packaging materials. This is where I was afraid you were going to fall asleep so I put in a moving picture for you. What are the materials, major materials of packaging? Well, in somewhat of an order here, wood. Huge area. Very few people talk about it. They think wood pallets. That's it.

But there are so many wooden packages out there that you lose sight of them because they're a tree in the forest. Paper, which is slightly different than that. And there are a lot of different types of paper. There is not one type of paper, so you say it reads through paper. If you say that, you don't know what the hell you're talking about because papers are treated, coated, laminated, different processing issues that go on. And all of those can affect their characteristics and either lend themselves to benefit RFID or, on the other side, block it. Then we have problems.

Plastics. And these are things that I'll spend a little more time with. Name me the plastic. You can't. There's, like, a billion of them. That's the beauty of plastics. You can build in the requirements that you want. You add a little bit of this, a little bit of that, and you have a gas barrier, a light barrier, a moisture barrier, all these things. And you can mix and match so you can design any plastic you want.

Metals. Huge opportunity. A lot of metal packaging still available. And glass, of course. Now, the interesting thing about glass-- well, I'll skip that. Now, from a packaging standpoint, there is no cardboard. And I've heard several people make reference, and it's OK because you hadn't had this class before.

But cardboard is not a technical term. And if you'll notice, in some of the presentations, cardboard in one presentation referred to rolled paper. Cardboard in another referred to corrugated. And then another referred to paperboard, which is like what's on the back of your writing tablets. And so from that standpoint, they're different terms. Solid, fibreboard would be your cardboard if you'll use that on the back of your writing.

Corrugated board. Your cardboard box. And I'm going to put this up not because you're idiots, but I just like to draw on the. Board OK? That's a cross section of a corrugated box. And I have it there for a reason that I'll get to in a little bit.

Now, the impact of these materials on RFID. Different frequencies exhibit different behaviors around different materials and applications, period. That's the nature of the world. Can't change it. You need to find the one that works.

Metal has a large effect on most RF systems, and particularly true at the UHF. It blocks it. It re-radiates it. It sends it off elsewhere. Now, interestingly, if you know that, you can use that to your benefit. And in our facility, we've been able to double our read range by directing things at an angle off of large metal structures. And it works wonderfully if you can control the environment. Now, in the supply chain, good luck. But in certain situations, you can do that.

Plastics. Now, plastics, because there are so many different ones, they vary all over the map. Some plastics are RF friendly. Some hate it. Common ones, your PETs, your Polyethylene Terephthalates, your Coke bottles, your polyethylene, or polypropylene, all of those are pretty RF friendly and can be utilized. But not all plastics react the same.

Now, interestingly, glass can be claimed to have little to no effect on RF. That can be true, but you keep in mind that glass is not glass. Whoa. All right. This is metaphysical already. Glass is like plastics. It's like paper. You order the type of glass you want to use.

There are different classes of glass. Those of you in the pharmaceutical industry know that. You can have class 1, class 2, class 3, class 4. And in changing that, when you're making your glass, you add a little bit of this, a little bit of that, to get different properties.

Think about in your kitchen, those of you that have Pyrex. Cookware. If you drop it, it bounces. That's not the same as your light bulb. Glass is not always glass. And the composition of glass can impact the properties. Now, I didn't have time to put in a slide of this, but here's some testing we did.

We took panes of glass, and it was class 2. If anybody cares, like your window pane. Clear, amber, and green. We took an RF tag read, got a read range, and then we put the tag behind glass. Our read range dropped.

We sandwiched the tag between glass. Our read range dropped. Huh? Shouldn't happen that way. But it depends on what's added. You need to think about that. Paper, little to no effect. And for the reasons I stated earlier, that's not always the case.

Paper has some real unique properties even if it's just plain, brown paper like you get in grocery bags. We're going to look at that. Composites-- they're all over the map. The only real composite I saw here was the bubble pack with Mylar, so it was a foilized plastic. And I'll tell you right now, that one doesn't read. It's a good insulator for RF energy.

Problematic matching has come up because sometimes, you have packaging and water-based products. Water is particularly problematic with UHF. If you move to a different frequency, the water issue can decrease so that it becomes more friendly.

They use energy through the Earth to communicate with submarines. We got a 500-mile-long antenna buried in the upper peninsula of Michigan so that they can use frequencies through water to communicate with submarines. You can use it, but it has to be really low in that particular case. The lower you go, the better it works.

But not all liquids are water. If you think about it, how many of you put water in your car? I hope it goes into your washers rather than your fuel tank because there's a difference. Gasoline doesn't have water in it. Your gas engine doesn't like it.

Motor oil does not have water in it. And so if you take those liquids, RF can go through those. So water-based problems is. Any product put in metal packaging. So your product can be perfectly read, and if it goes into a package that doesn't work, you have problems.

Now, the Cascade powdered soap that I mentioned earlier is a good example of a dry, granular product. Let's put it in a standard corrugated box. Will it read or not read? What do you think? Read? Not read? Doesn't read.

Why? It's not the water. One of the things you don't think about. Heavy iron content in the soap. And hence, it scatters the RF all over the place. So you can't generally read through a powdered soap. Who'd have thunk? Just looking up here, we have meats. We've been testing meats.

Silly thing. Water-based I talked about? This is a TI. That's a 13.56 tag. We also tested it with 9.15. Single cut of beef. And by the way, it was steak, and damn good when we were done testing. We ran them at chilled temperatures and we ran them at frozen temperatures

13.56, six you could read two or three stacked in a column and still be able to read through. UHF, you could read the top one, and that was it. Wouldn't penetrate to the bottom. When we froze those same cuts from each with the same tags, we could read five and six deep because the water molecules get bound up as ice crystals, and they leave gaps for RF to go through. So you can read frozen a lot of times with water.

And for those of you that care, it's dielectric constant. If you look at dielectric constant of water, it's 70 to 80 depending on the properties involved. If you look at the dielectric constant of ice, 3.5. Right through it. So pretty good stuff.

Some of the research. I just want to touch on these real briefly. Somebody give me a five minute sign when it's five minutes. Warehouse environment. This was starting way back when we first-- where in the heck do you use this stuff? And so back in '99, we started this research. Well, let's see if we can use it in a warehouse in developing a model for it.

Transponder effects on bloom time. That meat study, the first one we looked at, because the inlay was printed on PET, if you put that on the surface over the meat, even though it was on the plastic over the meat, it created a double barrier. And when you peeled the plastic off of the meat, you had a big purple spot there because meat turns red during oxygenation.

And so when you peel the tag off, because you have an oxygen barrier on top, you left a big purple splotch. And people were returning meats to the store saying, this crap is spoiled. And yet, if they waited 20 minutes, it would disappear because the meat becomes oxygenated.

Frozen and refrigerated temperatures. I just gave you that. That's John [INAUDIBLE]. He's now at Kimberly-Clark, an EPC member and a task group on something. Jeff Taslar, now with Simon, wherever Simon went. Effects of tag orientation and package content on readability. I have a slide on this that I'll share with you shortly.

Failure modes of class 0 in the lab. When you look at ISTA, the Institute of-- International Safe Transit Association. Excuse me. Mental burp. They run a series of dynamic tests that UPS, FedEx, DHL, may use for liability issues if something goes wrong with your package. They beat the hell out of it, and the product has to survive. That's their test in a nutshell.

Now, American Society of Testing Materials, ASTM, also has a series of tests. Shock, vibration, compression. And you can build your own distribution to fine tune so you don't over package. We did both test side by side with the same tags. And one of the interesting things we found was that it was really hard to kill them in transit, unless there is a direct impact to the chip. The chips were not affected by vibration, which surprised me. They were not affected by shock. And also, the shock was directly over the chip. And it's a brittle piece of silicon, glass, so it breaks.

And here's why I did this earlier. A little trivia for you. It makes a difference for survivability whether the chip on a tag is over the peak, over the slope, or over the valley. Try and plan that into your automated system. Yes.

[LAUGHING]

I'll tell you later. And we just finished one antenna configurations looking at product and tag types. And we evaluated with the same readers, and we looked at multiple readers. We looked at multiple classes of tags. Whether one antenna, two antennae, three antennae, or four antennae gave better results. And we looked at both linear and circular for different product mixes.

So real interesting. We hope to have that one published shortly because it's a fascinating study. One that's going on right now. And Richard-- he disappeared. This is what I wanted to talk to him about. Electromagnetic property measurement and RF signal absorption, evaluation for product stimulant.

I love these titles because they don't mean anything. But we are evaluating how much the materials downgrade moving through various materials because they all have a different-- if you look at a freeze equation, for those of you that know what I'm talking about, you have a signal strength. And when it reaches a barrier, if it's a packaging material, you'll get a lessening as it crosses that barrier. And you can actually measure these. And we developed some new equipment to do that. And that's coming up pretty interesting.

And then we did one on Department of Defense's RFID mandates. Blah, blah, blah. This is the chart that's kind of interesting. On the one side here with the product, you'll see that I have empty foam, empty bottles, rice, and water bottles. Those are 12 by 12 by 12-inch cases, cubic foot, with nothing in them, foam in them only because we are looking at some of the shipping uses. Empty PET bottles, rice in PET bottles, and filled water bottles, the same PET.

And if you start going across, the tag orientation at the top says outward-facing tags, where we had as many tags facing outward as we could. Inward-facing tags. You'll see problems there. Forward-facing tags on the pallet. Upward-facing tags on the pallet, and bottom-based tags on the pallet.

One of the DHL movies which I thought was interesting, when they left the tag on the product in the loading dock and the guy had to stop and run back and get it, the tag was sitting on the side so the reader could pick it up. If you took that same package and turn that tag down on the floor, chances are the reader wouldn't get it. Why? There's metal in the floor. Because when you build facilities, you put rebar down there. It scatters waves all over hell.

So anyway, this just shows that the wait are good reads. This is 1,200 reads for each test. Each box is 1,200 reads. Percentages of reads. And you can see that the white to the red, you had orientation issues. Not a lot, but statistically significant.

And in the product categories, as you moved across, you had certain orientations of the tags on cases that were problematic. And when you looked at both of those areas, the orange squares up there did come out orange. Real problems. Packaging and product issues that affect RFID readability, transmission, any number of words you want to put in there.

Now, again, this is Richards, and I won't-- this is some of the stuff we're doing on the electromagnetic properties and being able to measure energy that gets through packaging to a tag and being able to measure how much energy it takes to breach the threshold for a passive tag to send a signal back. And it's neat. We can talk about that later.

Now, corrugated board. When you add humidity to paper, so hydroscopic paper, it absorbs moisture to some level. It changes the moisture content. And if you see here, we have storage conditions. Three different storage conditions, three different moisture content associated with that. And guess what happens? As you go up in moisture content, . You start having an effect on the paper.

Now, it doesn't look like much, but what it boils down to is corrugated board or any other paper can affect RFID. It does not say it will. It does not say it has to. It can when you have high humidity. If you have low to medium humidity but the paper has already been exposed to high humidity.

Hysteresis is this thing-- Mark and I had a conference in Tokyo where we discussed this very topic. When you change a paper's chemistry by adding moisture and then dry it out, it never goes back to the same static condition. There's always a residual there. So it's easier to pick up moisture the second time around. So with leakage or condensation, that's an issue. If you guys are trying to ship down to help Katrina in the southern coast where it literally rains inside of warehouses in the summer, this could be an issue.

However-- and here's an interesting point. I hear this a lot in my presentations. That means we should go to RPCs. Returnable Plastic Containers. Or actually, there's about five acronyms for RPCs depending on the industry you're talking to.

And here's one of the things that I find with that. If you do-- and you can. They'll go, you can embed the tank. Absolutely right. No question. You can embed the tag, and it's protected. Those are good things. You can embed the tag in corrugated, too. I don't know. I have to look ahead. Don't look. OK, good.

If you embed the tag in corrugated, there's a problem with that inherently from an operations standpoint because you embed it, and those of you that have been in a corrugated plant, you see this stuff whipping off. And you place tags every so often. You then have to die cut to get that box plank. And if you're changing the dye, you don't know what's going to happen to that tag.

So that's really problematic. That means you end up having to inventory 8 foot sheets of board rather than dye cute blanks or dye cut boxes. That's a huge amount of space increase. Now, the other thing that-- OK. With RPCs, I'll cover that in a second. Don't let me forget.

These are just some of our test conditions. We have loading docks at the school. And in the bottom corner over here, you'll see one of my labs. And I run that-- I just put the corrugated up to make it look clean because it's a dirty lab, if you will, literally and figuratively.

But we'll turn on all the equipment and see what electromagnetic interference does with respect to different tag and reader combinations. We did shock testing. So we're doing drops on here. Here's a vibration test unit load, as well as column stack where we're trying to get the columns rubbing against each other to see if we could braid through to destroy the chip. Compression tests. You can do these all day long. Nothing ever happens, but they're cool to look at.

Now, here's some issues that we also found in looking at a lot of product package combinations. This is a seven-down footprint. Four and three cases. And the white means you got 100% reads in 25 trials going through a portal. And you have the red with various percentages up there.

Those tags didn't read, but they're all perimeter tags, and they didn't read because metal forklift blocked the RF from getting to them. I don't have it in here. We did a lot of studies on how much room do you need to measure in that gap and reflect off, but it's different.

Now, on the bottom is the exact same product, the exact same cases and tags, but I changed the stacking pattern. I agree it is a stacking pattern that rhymes with shit. It's a terrible pattern. You'd never use this. However, my point was to demonstrate that if you change stacking patterns, it can impact readability. That's all I wanted to prove.

Now, here's one where the green is the tag location on these cases. And we have the same orientation, the same patterns. And I just turned the tags inward rather than leaving them at the perimeter. And those red reads, 25 trials, not a single time that case read. These are individual tiers stacked on top of each other. Same with the bottom ones, even though you have the channels into the tags.

Now, here's just kind of a reversed. All perimeter tags on the top one. Good readability, like no failures. That's real handy. Inward-facing tags-- death, except on the top where there was no case surrounding it. Now, what this means, and we've done a lot of talking on processes here. One of the processes that may have to occur before RFID enables all the benefits we're talking about in the supply chain is to look at changing the pallet patterns or case counts to maximize perimeter tagging.

In the video that DHL showed, did anybody noticed that that pallet was a half pallet? It wasn't a typical GMA pallet like we use here in the United States. Grocery Manufacturers Association. A 40 by 48-inch pallet. It was a half pellet. And if you go through Europe, you'll also see quarter pallets.

And one of the benefits of that system is you always-- almost always. Pretty much always get that perimeter tagging opportunity, and therefore, better readability. Now, product impact. Water, we tested some, and we found a case that would be readable, non-readable. Readable, non-readable. Nothing changed. What the hell's going on? I'm going crazy here, all right?

What we found was we had heads of lettuce. And a head of lettuce would rotate and put a flat portion of the head on the back side of the case where the tag was. And if that hunk of water in a lettuce was up against the corrugated behind the tag, you can't read the tag. And that was demonstrated last night with the different thicknesses on the water with Dan. When you rotated the tray full of water, you needed additional thicknesses because you need to separate the tag from the water to allow the signal to get in and energize the antennae.

And here's a perfect example. We found it in lettuce. We found it in peaches. We found it in a couple of different products. We started looking at reading on shrinkwrap situation. Stretch wrap, excuse me. And this is a portal that has four antennae.

This is part of the antennae configuration and readability. And reading, wow, it's because it's on there for roughly 30 seconds while the stretch wrap is being put on. And we found some fun results, but that'll be out shortly, and I'll teach all of that.

One of the things we're currently doing now is looking at water on corrugated. Corrugated has huge markets and opportunities within produce. No question about it. And here, we've started a series of tests on these. We have produce trays, and in the top, we just have a squeeze bottle. Real scientific. Cost me, I think, $0.89 to empty and fill up with water.

And we spray on the tag. The one below that, we got a squeeze bottle. That was cheaper. That was, like, $0.39, and we just squeeze a stream on it. Now, on the top, we run the tap, and we have a calibrated hand splashing water across the tag, looking at different levels of moisture on the tag.

And here's one of the interesting things that we found. If you have untreated board, any water on the tag, the tag disappears. You can't read it. And in the bottom picture, you see how the water has worked its way into some of the holes of the case. It holds moisture. You still have problems. And you can't always read those after the water application stops.

However, if you have treated board and you do this exact test, as soon as you stop the water, whether it's a spray, a squeeze bottle, or a flood of water, the second you stop that water that drains, that tag reads again. That is no different than a tag embedded in a returnable plastic container. If you run water over those, the tags still disappears. There's no magic that if you bury a tag in plastic, you can still spray it with water and get the tag to read. You can spray it with water for cleaning.

But here was an interesting thing. My wife is here with me. And I was talking to her about returnable containers, and she worked for a company in Dallas. We made a one-way container for a company, and it was electronic company in Dallas. They came back a year later and wanted us to rebuild this corrugated box, and it was about the length and width this table. About this deep.

They had used it every week for a shipment to a plant and back for a year, and then they asked them to rebuild it rather than a new one. Out of corrugated. Now, it was triple wall, but there is a good reusable. Frito-Lay uses returnable corrugated boxes for all of their chips because they control the placement on the shelves, and then they tick the boxes back, and they reuse them, and they can reuse them for months at a time because they don't get beat up. Some good opportunities.

Now, There's what we talked about. Read stopped during water. They'll continue to fail if it becomes saturated, but they resume failing if it's treated. And with that, I'm going to sit down and start drinking, and I'm going to turn this over to Dr. [INAUDIBLE] from Florida. Appreciate your time and attention.

[APPLAUSE]

[INAUDIBLE]

PROFESSOR 2: I'm very sorry for some of you that were done with me yesterday. I'm always back. It's like a bad cold. I always come back. I'm going to go fast because we have lunch, and so I'm sorry [INAUDIBLE] listening. OK. Well, thank you again.

And we are going to talk about packaging and a few of the thing that Rob discussed a little bit earlier, I'm going to dressed them. That's very interesting. Very quick, it's-- I explained about the Center for Production Retailing yesterday. And we are trying to develop smart packaging for the food industry and the pharmaceutical industry.

And the one thing that we started is well in this area of RFID. This is what happened in 2003, when Fretwell, a company based in Plant City, Florida, came to us and said, we're going to give you an RFID lab and start to play with this thing.

And the reason why it was a good mass for the food industry is because we have already infrastructure. We have 14 cold rooms, temperature, humidity programmable. And we have two freezers. We have two [INAUDIBLE] container. One refrigerated trailer, and even a 727 freighter that they don't allow me to fly, luckily for everybody.

But the goal was, at that time, is that to get all the RFID hardware and software manufacturer to have a start there. And since then, every three months, they come and they upgrade our equipment, software, hardware. So that's pretty neat for that. We always get the new stuff pretty ahead.

So our lab is designed like Rob. We have everything to measure all the impact of packaging and things like. That you see, Rob? I use a drawing so I don't have to put the boards to hide my dirt under this thing. OK, so very quick. The first thing that we did was with [INAUDIBLE] and Fresh Express, prepared salad and a head of lettuce. And we did shipping from coast to coast. Studied the tag location, and then the speed of the load.

I'm going to go fast on that. The idea was to map a pallet and see where are the good place to put a tag and the other place that were critical not put a tag because you couldn't read it because the effective of the pallet. So we played for it with that for a while until we decided that we have to go further with that.

So we started to compare different materials-- plastic, wire bound, wooden crate, and corrugated boxes. And I apologize for the wood crate. I was still learning how to drive the Publix forklift. And the corners were pretty stiff on this thing.

But the idea was to compare what was the effective if you're using because these are coming from the same grower, and they have different kind of packaging and things like that. So we wanted to study that. And we came with a different thing.

But the problem that we discovered is that when people were looking for readability, read rate, we were having pretty low number. And they were like, oh, man. That's awful. But I said, welll, it's because we were losing the tag. You cannot read them if they are not there anymore.

And we started to discover a lot of falling tags everywhere. And that was a big issue. One thing that we decided is that, why we don't look a little bit further and see when you pack something in a package, it should stay with the package, the RFID tag all the time, at least identification. And this is where it started to trigger that we should always try to improve the way of mixing tag, RFID tag with packaging by trying to know if we cannot, in the process of making the package, just get the RFID tags inside and make it one step rather than many steps.

So we started to investigate that. So what we did is that we started to embed RFID tag on reusable plastic container. Of course, we reduced the use, the cost per use. So this tag is there. You cannot see it, but it's there. And that was doing with the injection molding plastic that we did that. So we can always track the base because the wall, you can change them. Because if you break one wall, you can change it. But the base is always the base.

And so we can always track the life of these RPC because sometimes, they are used in different industry where you're trying to use them for different use. And so what we did during injection molding process, and it cannot be removed. But the interesting is that we were always wondering, when you inject plastic, it's very high temperature, and a lot of friction in the mold. And is a tag can survive that, and can we locate the tag at the right place.

And if that happened, it was easier than we expected. They were very tough. And what is interesting is that I can cut pretty much the price of that by skipping a few steps. So I don't need a fancy RFID tag in this thing, and I don't need very much. In fact, we're going to see later, I only need the chips once in a while.

So the price of the whole process is made. And this thing doesn't require any new equipment for the injection molding company. Any company can do that. So what we did was so we started to invest on smaller container, which was more challenging because the thickness of the chip is what is limit the thickness of my wall. But you can always find a place to put it.

So as I said, we don't need these fancy labels. We need a chip, and that's it. And everybody can do it. So that's pretty cheap at what point, OK? So injection molding company can run a batch of regular container and just switch in a matter of a few seconds to with one with embedded RFID tag. And this is what we are doing right now.

Of course, everybody's like, oh, item level. It's way too ahead, you know? But it just proved that I can take RFID tag container and put that in this container and drive the price to very, very cheap to the price on most of the chip only. So that's very interesting on that.

Well, and also, we started to do with project with different nature of product. And of course, because of the water and what we said, one of the big issues that if I have my tag and with water, I cannot read it. So we sometimes, we have to redesign the package. Not very much, but slight chance that I can position my RFID tag to a location that it will not interfere with being interpreted by the food that I put inside.

So we're able to pinpoint location and redesign slightly some of these container and get these good read. In fact, I'm going to tell you something interesting. We did 1,000 container with tags embedded, and only one of them failed. All of them were good. So that was pretty interesting on that.

What we are doing also in 2000, right now, is that we are looking for smaller and thinner design. Some of them, we just want to read 6 to 12 inches. So we're going to need some help on the design, antenna design on this thing. So I'm just asking everybody to help.

On the pharma industry, well, this is something interesting because your container, if you put pills in it and you want to follow that, I can remove a label. But if it's inside the container, I cannot remove the label. It's inside the container. I can stack it up with tons of label. Well, it's still part of the container.

And we did that. And sort of the thing is that prescription drug, using [INAUDIBLE] container has been something that we're working in pretty close to be successful on this one. And also, we work on the blood product right now and packaging company that you put in when you ship the pharmaceutical product on this thing. That was a fast presentation, but I'm going to let you, after that, just doing that, we're working very much, but we need some cooperation also. So thank you very much.

[APPLAUSE]

Once it's fast.

Thank you.

[INTERPOSING VOICES]

PROFESSOR 3: We'll do the Laurel, Hardy thing. Jean-Pierre and I were talking. We were going to have a race to see who could do the presentation the fastest. So I'm going to win on this one. But all right. I'm first going to tell you guys who we are and why you should care. Then I'm going to tell you about what we're looking for out there as far as technology and why we want that. So we'll flip through. Or once I figure out how to work this. Ah.

MeadWestvaco. We're into consumer packaging. We're into three principal areas. And if you look at these three principal areas and you think about RFID and ubiquitous tagging, these are three areas where they're prime candidates for RFID. The media and entertainment here, you have these high-value items in small packages. You're ending up with high shrinkage.

You have the area where an out of stock is a big issue because if somebody walks in there and they don't find the title they want, they're not going to buy some other title. They're going to go to some other store with all the money in their pocket, and they're going to buy everything else they needed at that other store also.

Or to the consumer products. We heard about simply white earlier on here. That's another interesting thing for tracking out of stocks. And then we have the health care industry, where you have to be the huge issue of counterfeits. The FDA's basically just come down that basically strongly suggests RFID in the packaging there.

The other area that you're probably more familiar with MeadWestvaco, or at least the Mead name, is in the consumer and office products area. And we're into RFID in that area thanks to Walmart. We're at the pallet level in shipping our goods on that, in that product line.

Now, we've been looking at the RFID, participating in this area for about six years now. We were one of the early members of the auto ID center up here at MIT. We also founded a group in our company called intelligent systems. And I'm not sure if any of you had read about them. They were in the news for quite some time now here.

Basically, that group came up with an intelligent shelf system where, unlike some of the other ones that were out there where people had sent multiple wires to each of the antennas trying to reduce the cost, we found a way of taking one reader and basically using that reader to read 100 antennas and having a single wire running down the line of 100 antennas and bringing it back.

This, as you can think about this, is a really unique way of reducing the cost of the infrastructure by several orders of magnitude. And that was essentially our goal here as we got into this. We looked at the field and realized that for tags to be ubiquitous, the tags were going to have to be commodity-type items. And there were plenty of players out there like Alien-- we were in discussions with them-- who were doing a very good job of that.

But people weren't really addressing the infrastructure successfully. So now, this last year, we sold the intelligent systems or most of the Intelligent systems to an outside group so that they could really concentrate on it full force. We still have a residual interest and are following it because we do think that it's very important for success in this field for that company to be successful.

Our capabilities at this point in time, we do have production capabilities for doing item-level coding of tags, of testing those tags in line and tagging boxes. We have not seen the pool from the customer base, but we're positioned, and we're trying to improve that position daily so that we're ready when the market pull comes along. But basically, our ability to tag is anything we can put an EAS tag on today, we can switch over and do an RFID tag.

Now, what we need as far as technology. We're looking for the things that are going to make our customers successful. And probably the primary thing there would be item-level tracking at low cost. And we've been hearing discussions yesterday and today on some of the things that would go into reducing the cost of the tag and such.

But I also want to remind everyone that this doesn't necessarily mean 96-bit RFID. There's a lot of attention out there to chip lists, tags, to organic RFID. And these are areas that we're exploring and discussions with various companies on.

But if you were going forward looking into the field, one of the things that I want to caution everyone on is that these things cannot sit there and expect to come in and require a whole new infrastructure through the whole supply chain. I mean, the 96 bit is a juggernaut going down that road there. We're going to see that infrastructure go in there. Or if the organic RFID can only read at 125 k megahertz and you don't have an agile reader that can read at both points, you're going to have a hard time selling those, that organic RFID in there.

The same with the chipless tags. If you've looked at the various chipless technologies, it's very interesting, and it's very appealing to us because our desire is to be able to just print the RFID on there. That's the way we're going to reduce the cost down for our customers.

But again, what are you looking at when you get a chipless tag? You're probably not looking at 96 bits, and you're definitely not looking at the same reader that you're using for reading your silicon-based tag. Now, there are value propositions out there that would draw towards things, these technologies. If you can identify the niche market that you're going after, we may have something to talk about.

All right. The other thing is we have to look at the total cost of the tag over the lifetime. It's not just the cost of the chip, and I think we've heard that before. It's the cost of-- how much does it cost to actually put it on the package? What's the antenna cost? What's the crossover cost there? What's going to happen as far as testing. How do you handle the rejects when you get failed reads in the supply chain? How are you going to handle those? Those represent costs.

And then finally, and we've heard that alerted to before, this disposal issue is going to come and catch up to us at some point in time here. What is in your antenna? Look at Europe. Look at-- there's places in New England that are starting to look at the metals and the landfills.

And then the last area is one that's gotten a lot of attention here, and I'm glad to see it, and that's in the whole area of track and trace. Track and trace is a very, very valuable thing to look at, especially when you're looking at the pharmaceutical industries. But what's going to be out there in the data management infrastructure? Who's going to come up with that? How are we going to handle this data asset from various entities in the supply chain? That's it. I beat John Pierre.

[APPLAUSE]

PROFESSOR 1: I guess we're going to run this ourselves, so if you have any questions, come on down. Sorry, we felt like Miles Davis there with our back to the audience. But we wanted to learn something new at the same time, and it's hard to do it that way. So excuse us. Yeah.

AUDIENCE: OK. Just one question. Again, for what changes are you seeing to the metrics as you experiment with this technology in your packaging design? What do you measure to measure the performance? Is that measure changing? Units that you measure may be changing. What have you experienced with all your testing or what you might see in the future?

PROFESSOR 1: I'm not sure this is the same answer, but I don't see much new at all. Honestly, units are the same that I used in my graduate work studying random vibration as an energy source. RF is a great area, and I'm not here to disavow it in any way.

But it's a technology. It's not a panacea. With all due deference to previous speakers, I don't think it's worthy of a discipline. I did get caught short here briefly by asking the gentleman from IBM if they still had bar code specialists on staff, and he said, yes, we do, although he might not have been sure what they did. But I know in Michigan, we've gotten rid of bar code specialists.

And one of my students is working with Simon Langford at Walmart running their lab. And when he was hired, the comment Simon made was that we hope in three years you don't have a job because the intent was to make this so broadly based across the company that it becomes as common as UPC, and you don't need anything special. It's just an adaptive technology that helps.

AUDIENCE: Thank you.

AUDIENCE: Hi, I'm Patrick [INAUDIBLE] from Georgetown University. And I want to thank you guys first for this presentation. I think it outlined a lot of the shortcomings in this technology set in on--

PROFESSOR 1: Opportunities.

AUDIENCE: Opportunities, yes. Absolutely. And I've sat in on several government meetings on launching RFID for identity management. And the shortcomings that I'm seeing time and time again are the lack of understanding from, and I don't want to name names, but these consulting companies that kind of promise RFID in a box and passive allowing you to drive through at 55 miles an hour and things like that. And it's just not being answered. So I think research like this would be very advantageous to be out there in the public for the industry.

My question is on pharmaceutical. The FDA has asked to secure around counterfeiting that there's over, covert, and forensic. And in the launches that are out there now, you're seeing overt and covert. You're not seeing forensic. And I'm curious if anyone can answer that.

And then my last as a potential wag of the finger. I hope none of you are responsible for those damn huge plastic containers for my small microchip that are frustratingly impossible to open. So thanks again.

[INTERPOSING VOICES]

PROFESSOR 1: I don't have a really good answer, I guess, on the forensic. We have done work with both overt and covert, and there are much better experts than at least the three of us on that. It's kind of interesting. If you guys pull out $100 bill and just pass them forward, I'll show you how they have all of these security or anti-counterfeiting techniques involved.

And for those of you visiting from different countries, our currency now has 20 overt or covert anti-counterfeiting detection devices built into it and at least 10 others that they won't talk about. But there's roughly 30 anti-counterfeiting features in an individual bill. And those are the people you really need to bring into this discussion because I'm certainly not a specialist in that.

PROFESSOR 3: All right. Well, I'll answer that. I'd like to answer that. We're on it. We can't tell you what we're doing, but we're on it, and we have those three areas covered.

PROFESSOR 2: Very quick. And also, on the area that we never discuss is temporary evidence. And have you seen something of plastic? It said if it's not there, don't use it. But if it's out there, you cannot read it anymore. And so we're discussing, and the best protection for [INAUDIBLE] is that nobody can see it. And this is what we're working on.

AUDIENCE: Thank you. Good presentation.

PROFESSOR 1: Thank you.

AUDIENCE: Yeah, John Helford from Mars. My question is, how is RFID starting to work its way into the curriculum, particularly undergraduate, because it's important that they know? And also, how are you training the guys that aren't in school anymore about the utilization of technology in a supplier base? I'd be interested in that question.

PROFESSOR 1: From a Michigan State standpoint, at least, I started teaching a class on RFID and packaging two years ago. And it's been an elective class, but I've had really good turnouts not only from packaging but from engineering, from supply chain management, logistics, because all of these cross over, these areas.

And we now have companies coming in to hire our undergraduates and even our graduate students that will not even interview them if they haven't had the class because this is an area that companies are trying to find those answers and they're trying to find people that have hands-on work and feel so that they come in hitting the ground running, as opposed to having to be trained.

They're also, just like yourself, conferences up the wazoo. You know, JP and I've talked repeatedly about we could be at a conference every week of the year. And if you could get more of them in Hawaii, we might. But that's really what you're almost limited to. But we are developing an online, web-based program for recent graduates like yourself.

PROFESSOR 2: Yeah, very quick. And [INAUDIBLE] our packaging science program. Almost every course is where you can have RFID, a topic in it is already there. So we have a chapter in transportation, distribution, food packaging. We have customer product. All these packaging courses, they all have chapter where it's suitable to put it inside.

PROFESSOR 3: And well, basically, we've been talking to our senior management about it for probably six years now. And I think they get it now. We're way past the early days when people thought RFID meant you'd read them from satellites. I think if you cornered anyone in our senior management team, you'd have a pretty good conversation.

PROFESSOR 1: Last question.

AUDIENCE: Hi. My name is [INAUDIBLE] from Gillette P&G. As part of EPCglobal, there's a strong effort to try and standardize on measures and metrics and, like you mentioned, John [INAUDIBLE] and both Jeff [INAUDIBLE] are co-chairs. I'm the third co-chair of that group.

We'd like to get more academic involvement into that group. How do we make that happen so that you're not going off and doing these tests that are very interesting, but if we can try and synergize on those? I'd like to hear your thoughts on that.

PROFESSOR 1: Great issue. I actually had a conversation with some people from EPCglobal yesterday to try and synthesize some of the work we're doing. I'm a co-chair-- actually, a chair of a new task group within ASTM, the American Society of Testing Materials, where we are developing procedures and reporting on how you test. Case loads, pallet loads, military applications, pharmaceutical applications, et cetera.

We want to work in conjunction with you on developing these and share all the data. Where we're different from EPC, because it always comes up, is that we are reader tag frequency agnostic. We don't care what you use. Here is a standard procedure for measuring readability of a case, readability of an item. Read distance, read fields. Military. Whatever it is.

And so if it fits into EPC through 13.56, 9.15, they might be identical. But if you have a closed loop system and are looking at that 134 or 2.4, 5.8, and even different frequencies from that-- there's so much in military at 4.33 right now that we just want to set up what that is. And if anybody contacts me, I'll be happy to respond.

PROFESSOR 2: Maybe I can do something about it, about EPC and the standardization. I would say that in our lab, we touch many, many areas. Some of them will fall under EPC what you're looking for, and that's going to be good. But we still are going to keep doing other areas because the request of other applications is pretty big. And so if some of the things that we do will fall under EPC what are you looking for, this is great, OK? But we still going to have a lot of things that we want to keep running also. Thank you.

[INAUDIBLE]

[APPLAUSE]