

# De La Rue

## Investor and Analyst Day

3 October 2017

### Opening Remarks

**Martin Sutherland**  
**Chief Executive Officer**

#### **SLIDE 3 - Agenda**

Welcome, everybody. Thank you very much for coming along to our capital markets day.

I just need to do the kind of health and safety brief. There is a fire alarm test this morning, which is going to be about now, so it's 9.30. After that test, we have no further tests planned. The fire exits are there and there. If you hear a fire alarm, please make your way out the building. Follow any member of De La Rue's staff and we congregate in the car park in front of the building.

I've got all of my senior team here today, so there's a quick wave from my senior team. Jitesh is here, CFO; Brian is our new COO, who joined us recently so, if you've not had a chance to speak to Brian, he's been with us now for two months, three months. He's got some interesting first impressions, which he has been told not to share with you. He has got some things he could share with you. Ed Peppiatt is our Chief Counsel. Selva (CTO) is kind of the star of the show today.

The focus of today's brief is all on innovation and our technology function, and what we're doing in terms of product management and new product launches. That's Selva's remit within my team, and he's got some of his team here with us today as well to take us through the presentations. I'm missing Richard Hird, who's my Chief Commercial Officer, and HR Director.

The plan for today is that I'm going to give you a quick update on the strategy just to remind you what we said the strategy was, back in May 2015, and give you a quick update on how we see progress against that strategy. I'm then going to hand over to Selva, who's going to give us an overview of what he does in his team, what the CTO function is all about, what we're doing in relation to product management and new product innovation, and then we're going to do a deep dive into three areas: security features and holography from Ulrich and Brian; we're going to go through our design function. We have the largest design function in the currency market; 60% of all new banknote denominations issued last year were designed by the De La Rue design team. We see our design team as a great way of engaging the customers, so that's why we're going into design.

The last piece is to go through digital and software, so we're going to talk through a number of different software products that we've launched in the last year or two. This afternoon, we'll actually give you some demos of those security features and of those software products, so that's the plan.

## **Strategy Update**

**Martin Sutherland**  
**Chief Executive Officer**

### **SLIDE 5 – A clear plan to transform De La Rue**

Back in 2015, we launched the revised strategy for the business. You can think about this strategy in two halves. We did a dispassionate analysis of De La Rue, the markets that we play in, the customers that we work for, the competition that we're up against, and we said, 'Where do we see downside risk and what are we going to do about that downside risk? Where do we see upside opportunity and how can we tap into the upside opportunity?'

In terms of downside risks, there were three things that stood out. One was we had the cash-processing business, which was a loss-making business. The year I joined it lost £8 million in operating profit during the year, so we said, 'Okay, we need to fix CPS.' Our currency print business, whilst it's a very profitable business, there's a high volatility of demand for banknotes. What we wanted to do was ensure that we could align the capacity we had in that business against the market demand and also introduce flexibility in that capacity to enable us to flex our cost base effectively, up and down with the demand that we saw in the market. The third risk was around paper. Our paper business again is profitable, so it wasn't a burning platform for us, but we see oversupply in the currency paper market and therefore we needed to think about what we might do about that.

In terms of accessing upside opportunity, we saw a number of areas for growth. Security features are an extremely profitable part of our currency business and an area where we have a rich pool of IP and technology. My analysis was that we weren't exploiting that pool of IP well enough to enable us to launch new products to market and that's one of the areas we're going to focus on today.

Polymer is a new banknote substrate. We're one of two providers of polymer to the market. We have a niche position, in that we were the second to market, so we see an opportunity to grow market share in a growing market for polymer. We'll talk a bit more about that later.

Outside of currency, our identity business and what we call our product authentication business, so that's brand protection and tax stamps, both of those areas, we have good niche positions – a very strong brand position and a very strong niche in those markets – both of which are growing, both of which are bigger than the currency market overall. Therefore, they're markets that we think, with a bit of investment and a bit of sales focus, we can take market share and again start to grow.

Over time, what we're looking to do is rebalance the portfolio, not away from currency. It's not that we don't like our currency business, but will just rebalance the portfolio so it is more equitable between currency, ID and product authentication.

We also said we wanted to strengthen the balance sheet, back in May 2015, and Jitesh is beaver away on various things like what we can do about our pension deficit. Are there levers we can pull to address that particular issue? Also in the last two years, we have been a cash-generative business. The previous five years before that we weren't, so we've got a renewed focus on cash, cash generation, working capital and so on. The last thing that we said in the strategy was that we need to do something about the culture of the business. We wanted to

create a more high-performing, dynamic, driven, accountable culture and we'll come on and talk about that later on in this presentation. That was just a reminder. That's what we said back in 2015. I'm happy to take questions, by the way, if people want to ask questions along the way.

## **SLIDE 6 – Progress since May 2015**

What have we done since then? The progress report is down here on the right-hand side of the slide. We sold the CPS business. Somebody took that off our hands and actually paid us £6 million as well for the pleasure. The paper business, we are still in – how do I describe them? – complex and constructive conversations with third parties about what we might be able to do with our paper business. The construct we're basically looking at is, if we can form a joint venture, we can use the joint venture as a vehicle to consolidate the industry. We have ongoing conversations and we are making slow and steady progress. Let's put it that way.

In terms of print capacity, I've got more later on in the presentation about print capacity, but we launched a manufacturing footprint review; we've reduced our capacity by two print lines; we've taken out the associated overhead and costs. We're expecting to see £13 million of savings generated for financial year 2018-19 onwards. One piece of the print equation was to reduce the capacity, so that we can keep that capacity more highly utilised within the business. We also said we wanted to increase flexibility by working with third-party outsourced print partners.

The other part of the print equation was that we wanted to increase flexibility. We were going to do that by working with third-party printers. Two years ago, we outsourced the production of half a billion of banknotes. Last financial year, we didn't outsource any. I think that demonstrates the fact that we actually used that outsourced capacity as flexibility and a buffer against the variable demand in the market.

In terms of our growth areas, if we move down to 'invest and build', our group revenues are up 5% over the strategy period, on an average CAGR basis. Our ID and PA&T businesses are actually growing at a higher run rate than that. Last year, both of them increased profits by a strong double-digit growth. It doesn't say it up there, but we also almost quadrupled our volumes in polymer, which again was a key growth area for us.

We've increased our R&D investment over the period by 54%. We said that one thing that we wanted to do as part of the strategy was make sure that we were accessing the talent we have in our R&D department. We were investing in new intellectual property. We were bringing more relevant products to market quickly, and so that investment in R&D has been important to drive that for us.

In terms of deleveraging the balance sheet, net-debt-to-EBITDA ratio actually has gone up slightly but, if we adjust those figures ex the acquisition of DuPont Authentication – we spent \$25 million on acquiring DuPont Authentication during the last financial year – then actually our net-debt-to-EBITDA ratio has come down slightly. We are deleveraging the balance sheet slightly.

It's difficult to measure culture change. I was trying to find a stat where I could say, 'This is how we can measure the progress of culture change.' I would say two things maybe. We've been a cash-generative business for the last two years. Jitesh and I both said, 'We are going to focus on generating cash.' We've told everybody in the business that, every time Jitesh stands up and speaks at a town hall event, the only thing he ever talks about is cash. That message is starting to get through and we're starting to see the results of that, so that may be one metric. The other one is that our order book is up 71% between 2015 and 2017. Again, we've put a renewed focus into sales and marketing. We've churned a lot of the staff in the sales team. We've put new incentives in place. We've put new performance management measures in place, and we're starting to see the results of that focus as well. We're starting to see a change of culture within the



business. I don't think this by any means is a finished item on my to-do list. It will take time. That's the progress.

## **SLIDE 7 – A more diversified business**

A few other points to note then: as I said at the start, we're trying to rebalance the portfolio from currency into ID and product authentication. If you look at the chart over here on the left-hand side of the slide, you can see that during the period we've managed to see the investment we've made in R&D enable us to launch new products and those new products have enabled us to start to grow in our growth markets. This tiny little sliver in here is our polymer business. Two years ago, we didn't really have any polymer volumes to talk about at all. That's gone from nothing to 100 tonnes to 380 tonnes. This year, we expect that number to more than double again, so we've got hockey-stick growth going on within our polymer substrate.

In security features, which is the pale green at the top of this chart, ex the major security features contract that the market is aware that we lost, if you look at the underlying growth in our security features business, which is what we've shown on the chart, again we've got good underlying growth. We are winning new customers with new security features. Overall, we've got a slightly more diversified business today than we had two years ago.

The other issue that we identified in 2015 was around customer concentration. When I first joined the business, we were very concentrated in terms of customer mix. What we're trying to show here, on this slide of the chart, is that customer concentration has reduced over the last two years. The number of accounts with more than £10 million of revenue has more than doubled in the last two years. You can see that, actually, the spread of our top five to top six to 10 to top 11 to 20 and so on has smoothed out across the period. Our top 35 accounts in the business are up 21%, in terms of revenue over the last two years, so I think the customer concentration thing is starting to resolve itself, again through the focus of the sales team and account management, making sure that we target our services on the right customers.

## **SLIDE 8 – More focus, better returns**

In the last three years, group margins are up, as I'm showing on the left-hand side of the chart. Obviously the CPS sale helped with that. It was a loss-making business, so that will have driven the jump from 2014-15 to 2015-16. We are finding that, because we have a strong order book, we can maintain better pricing discipline in our print and in our paper business. Pricing has been pretty stable in both those two parts of our currency business over the last couple of years. Also, cost control, as part of the footprint review, we've taken out heads, but also we have a general operational excellence programme that continues to run around the business, which means that we are being more efficient across our manufacturing footprint and we have reduced headcount over the period, which again has helped to drive up margins.

We're also talking now about real margins, as opposed to everything bar the exceptionals. Jitesh, when he joined, decided we were going to try to wean ourselves off the exceptional charges, which had become a little bit of a feature of De La Rue previously.

We've got an improved focus on deployment of capital. The CPS divestment again helped in terms of the stats around capital employed, but we're now focusing our capital far more on the growth areas within the business. 85% of our spend in material science is focused on our growth areas, so we're being far more targeted around where we invest our capital. Also, because we're focused on deleveraging the balance sheet and cash generation, we actually have a dedicated team now working on inventory with credit control and so on – everything we can to squeeze cash out of the business. That team is having a significant impact.



## **SLIDE 9 – Effective cost management and efficiency programmes**

We've churned a lot of heads in this business in the last two to three years. If you look at my senior team, the executive leadership team, they are pretty much all new with the exception of Ed actually. Ed's a very good lawyer, a very good lawyer.

The next layer down, the senior leadership team as we call it, about 50% of that population has churned in the last two and a half years and it's become a slightly smaller community, which has helped us with the cost base. 40% of the sales force has churned in the last two years, most of that based on performance grounds. Also, we want to bring in a different calibre of salesperson to help us focus on the ID and the product authentication growth, where the sales model is a slightly more consultative sales process. We're upskilling that team.

We're investing in training. We've got leadership development training running across the entire company, backed by Harvard. We've put a lot of the senior team through that and we've also adopted the Miller Heiman sales methodology, so all of our salespeople are now trained in a standard sales methodology, which we use again across the group. Obviously the sale of CPS helped drive efficiency, but we've also taken out about 10% of the heads across this business, in addition to the sale of CPS over the period.

We've put a new incentive scheme in place across the organisation. For the general management population, we have an in-year bonus that is based on revenue, profit and cash metrics. There's a smaller population of people who are incentivised with LTIPs, long-term incentive plans – share options that pay out based on earnings-per-share growth and ROCE growth. We have the senior team incentivised and aligned, hopefully, to the ambitions of our shareholders, but we've also changed the incentive plan for our sales team to make it far more aggressive than it was when I first joined.

We've reduced the number of print lines in the business. As I said earlier, we've reduced it by two. In the last year, we produced 7.2 billion banknotes with two fewer print lines than we had three years previously, when we only did 6.6 billion. We're expecting this trend to continue.

## **SLIDE 10 – Manufacturing footprint programme**

The manufacturing footprint review, certainly for all of our investors and analysts, there's no news on this slide. You're very familiar with this. We've taken out two print lines in Malta. Our original plan was to take out three print lines but, actually, because of the strength of our order book and because of the volumes of notes we were producing, we concluded that we were better off keeping one line for the moment. We've got flexibility around the footprint; we can continue to rationalise print lines if we need to, in the future, but for the moment we're comfortable with the current footprint that we have.

I thought you might be interested to see some stats around what else is happening in the market. What are our competitors doing in terms of capacity? We think, back in 2015, that the capacity in the commercial market was about 25 billion banknotes. The global market today for banknotes is 172 billion, of which 13% is produced in the commercial sector. If you do the maths, I think that gets you to about 25 billion. Anyway, that was the capacity that was being held by us and our competitors.

We took out about 1 billion banknotes of capacity with our own footprint review. G&D, our German competitors, closed a couple of print lines in Munich a couple of years ago. They took out about 1.5 billion of capacity. Crane has announced, in the last year, that they are opening a new print facility in Malta and putting in one print line there. That will increase their capacity by about 1.5 billion. We are actually not sure if that is new capacity or substitutional capacity for the



print facility that they have in Sweden. It may be additional capacity; it may just be substitutional. You will have to talk to them about that, not us, but that is my suspicion. Then there is a smaller European player, called Enschedé, which has announced that they are going to exit the market. When you do the puts and takes on that, we think the capacity has come down from 25 billion to about 22.5 billion over the last three or four years. Again, that is generally helpful in terms of the utilisation of our own print facilities.

## **SLIDE 11 – Growing markets, growing opportunities**

So just turning our attention to growth and growing markets, we say this a lot to our investors and people often ask the question, 'What's happening to cash? What's happening to cash in circulation? Is it declining?' Actually, our investors generally accept that cash is a structurally growing market.

Cash in circulation is growing structurally at about 3-4% globally. Even in the UK, cash in circulation is growing at about 5%. That is a Bank of England stat on the Bank of England website. You can look it up yourself. Many central banks publish circulation stats; a lot of this information is publicly available. Globally, cash in circulation is increasing at about 3-4%. What drives that? It's correlated really closely, and we've put up these charts here, to GDP growth and population growth.

Why? Basically more people walking around with a wallet, doing more transactions, equals more cash in circulation. You can multiply the two numbers together. Actually, you can see they're pretty well correlated across the different markets in which we operate. That's also true for our passport business and our ID business. Again, if you've got more people crossing borders, more people accessing government services within a country, more people require ID cards, passports and so on. You could actually say that our ID business is also correlated to GDP and population growth.

You'll see from the chart on the right-hand side here that the markets that we are most exposed to are those that tend to have the higher population growth and the higher GDP growth. If I take that global average of 3-4% growth in currency, in the markets that we're most exposed to, I suspect that the number is slightly higher than that global average. Demand for our services is growing.

## **SLIDE 12 – Demand for cash is strong**

Demand for cash, just to focus in on that for the moment, here the example is the US. Cash volumes are actually exceeding GDP growth for the US. What is this chart showing me? This is the different denominations across the US currency, and that's real GDP growth running across the top. You can see there's a bit of a hockey stick going on, in terms of cash in circulation in the US. You'd imagine that the US, the UK and more advanced economies are those economies that are adopting electronic payments faster than the rest of the world but, even in those advanced economies, people are still very reliant on cash. Interesting for a financial focused audience is 2008, the banking crisis, actually I think there's a definite kick in the graph here. People turned more to cash post the banking crisis in 2008 than they had done historically. Why is that? Because they literally take cash out the bank and put in a shoebox under their bed. They use it as a store of value. If you think about cash as a transactional mechanism, it's also used as a store of value. So demand for cash is definitely strong.

## **SLIDE 13 – Cash as part of payment ecosystem**

We would say that it's kind of here to stay. Again, there are actually some articles in the *Times* today – I don't know if you've seen that. I read that coming in this morning. There's a whole piece about electronic payment alternatives to cash. Take a look. There's actually one article in



amongst all the ones that are giving you the hype about Apple Pay and Google Wallet and all the other things that basically says, 'Cash is here to stay.' 60% of European citizens don't have a credit card. 38% of the world's population do not have a bank account. 2 million people in the UK do not have a bank account. 75% of the world's population live in a country where 95% of transactions are cash-based. 85% of all transactions in the world are cash-based. Cash is an important part of a payment ecosystem.

Even if you think it's going to be eroded by the advent of electronic and alternative payment mechanisms over time, and maybe it will be, it will still be an important part of this payment ecosystem. It's anonymous, which is really important for some transactions. It's free at the point of use. It's free to the consumer. Credit cards and all these other payment mechanisms are not. It always works; you don't need a reader or power supply or something else. It is the payment mechanism of last resort. For many reasons, I think it's here to stay.

#### **SLIDE 14 – Investing in new capabilities**

We, as part of our footprint review, said that we were going to increase our capex investment last financial year and this financial year by £30 million, over and above our standard run rate of capex. £15 million of that £30 million we were going to put into our footprint review to rationalise and modernise our currency print equipment. Then the over £15 million we were investing in new capabilities in the identity market and product authentication market.

There's a picture up here of me giving a presentation, watched by the Maltese Prime Minister. That was us opening our new polycarbonate line in Malta. We have made Malta our centre of excellence for ID and product authentication, and we now have our first customer orders being produced on that polycarbonate line, so we invested in that and we've also invested in new print equipment for product authentication.

We obviously made the acquisition of DuPont Authentication during the course of last year, a \$25 million acquisition to buy \$14 million of revenue of a profitable business, which will be earnings accretive for us in the first year. Why did we buy it? Mostly because it has a really interesting technology platform, which Brian is going to talk about later in the presentation. Lippmann holograms are particularly difficult to make. They're particularly difficult to make at volume. If they're particularly to make at volume that means they're great as a counter-counterfeit measure and this particular division of DuPont has cracked that problem, so great technology currently focused on the product authentication and identity markets. We think we can also repurpose that technology and, over time, get it into our currency market.

Just a final investment, systems and infrastructure up here. Again, we're also generally improving the IT infrastructure around the business. The most prominent programme to date is our finance programme, so we're replacing 19 general ledger systems with one. It is like open heart surgery within the Finance function. That is progressing to plan and to schedule, and we've got various other IT systems upgrades that we would seek to make out of our general capex run rate in the coming years. We're investing in new capabilities.

#### **SLIDE 15 – Investing in sales**

As I mentioned earlier, we're investing in sales. We've churned about 40% of the sales force over the last couple of years. We are seeking to move to a more direct sales model with our customers. Historically, De La Rue has been very dependent on third-party agents, who work on a commission model, scattered around the world. What we're seeking to do is move away from that, move much closer to our customers to have a direct sales relationship, so we've opened up a number of sales hubs around the world. We have one in Miami; we've got one in the Middle East in Dubai. We've now got a direct sales force in China. We're in the process of opening up an



office in Kuala Lumpur in Malaysia, and we are hiring local people to engage locally with our local customers.

As I've said, we changed the incentive model. I said that earlier in the presentation, and we've also put a standard sales methodology in across the piece, so this is a rebuilt, refocused and retrained sales team.

## **SLIDE 16 – Investing in product**

I think this is the last slide from me and then we'll hand over to Selva. We're also investing more in product, and this really is the central kind of theme of the presentations we want to share with you today. If you look at the fundamental value of De La Rue as a business, is it that we are a security printer? I don't personally think so. Is it that we have intellectual property and technology that is difficult to counterfeit? That, I think, is what customers ultimately pay for. Whether or not you're buying a banknote or you're buying a passport or an identity card or a brand protection label, or any of these things, they have to be a physical token that is difficult to counterfeit. The thing that makes it difficult to counterfeit is the cleverness of the material science, the inks, the taggants and the various bits and pieces that we put into that physical token that mean that, frankly, not anybody can make it. If anybody could make it, then it wouldn't be difficult to counterfeit. That's the fundamental value of our business.

My personal view is that we'd under-invested in that capability in recent history. When I joined, we set up a product management function. We hired a new Chief Technology Officer, Selva. We've hired a number of new product managers, some of whom are going to speak today, and we've bolstered our investment in research and development. All of those things mean that we're now launching more products to the market. I think there's a build on this slide.

If you look at the number of products that we launched back in 2012-13 and 2013-14, it was one or two products a year. At the annual currency conference earlier this year, we launched six new products, four new security features and two new software products, so I think we're starting to see the fruits of our labour in terms of the investment that we've made in product management. That's what we're going to spend the rest of the day focusing on. That was it from me, just in terms of the warmup act, if I can put it in those terms.

## **Driving Innovation**

**Dr Selva Selvaratnam**

**Chief Technology Officer**

## **SLIDE 19 – Driving innovation**

Good morning. Martin painted a picture of how we are moving forward. Now I'm going to tell you what we're doing to innovate within De La Rue itself. De La Rue has been an innovator in the past, but it's never been consistent or enthusiastic about it. Our intention is to change that and it is changing.

What I'll do today is go through three themes. I want to talk to you about three areas that are paramount to where we want to go to. One is security features. Security features is the bread and





butter that drives a lot of the businesses we have, from currency to ID to tax stamps to brand protection. This is the taggants, the security features, the methods of printing – the thing that makes it difficult for someone to counterfeit what we're doing. And it's a layered approach; it is never about a single thing. It's never about a hologram on a note; it's how the hologram sits in with the print and the print sits in with the taggant and the taggant sits in with the UV workings we've got in the thing. It's a layered approach, much like software.

The next part would be our software offerings. Software is not something De La Rue has actually driven well in the past, but it is an area that allows us to derive greater benefit from our tokens. The tokens we supply, as you all know, are currency, passports, brand protection. They're the same tokens. How do we expand our offering to bring our customers in today's world, one, and two, to expand our revenue and our bottom line? The third one is how we bring something Martin's already mentioned. We have a large design team. It differentiates us in the marketplace. How do we bring design to the forefront to differentiate even further?

Now, we innovate in De La Rue not for the sake of innovation. As always, it's about the top and bottom line. Fundamentally, innovation is used to drive product differentiation, and that's normal. Every company does that, but we want to push it even further. The second one is to drive business differentiation. It'll allow us, by a portfolio approach, to actually offer different things into the same marketplace we're into. Thirdly and very importantly, it will allow us to bring new business models to the marketplace – services in terms of software, consultancies in terms of print consultation – we are a printer at core, and other offerings into the marketplace that will broaden our scope in the marketplace. Those are the three reasons we push innovation.

I'll go through an overview of the products and marketplace, the general areas we work in, what is the size of the market, what's our play in it, what do we do there. I'll talk about how we leverage common platforms to accelerate our market reach and accelerate our innovation. The security features that we use can be used multiple times, in all the markets we want, in slightly different ways, so we invent once, use many times. That's the theme you'll be following, rather than invent many times for different markets. Then increasing the velocity of our product innovation, our product and services, we need to increase what we have. We need to have a future-looking roadmap and sell the futures that come with the roadmap. Innovation is not just about today; it's about what we are doing tomorrow, the day after, the year after and the month after. It's about selling the roadmaps and how we move forward with it, particularly in the software world we're beginning to move into.

## **SLIDE 20 – Our key markets in summary**

Right, our markets, let's start with currency. As Martin has said, the whole market, 172 billion notes, is issued every year. It's growing at 3-5%, linked heavily to GDP, as Martin has shown. We have 27% of the commercial print market, which is 13% of that market there.

There's a trend to use alternative substrates, such as polymer. DLR Analytics has been brought in to help predict cash requirements of businesses to reduce some of the lumpiness that results is you don't have a means of predicting when you need cash, using big data analysis methods. Nikki will be talking about that a little later. More and more features are being embedded into notes to protect against counterfeiting, especially high-value notes, so it's a layered approach again. It's not about one thing on the note that protects you; it's multiple things working in concert, making it difficult for you to copy the note. That's the trend.

Identity is a very large market. That market includes software solutions. We have 32% of the token market and of the passport market. We supply passports for 27 countries, including the UK. That's our market reach. Our approach to that market is flexible financing. As stamps move forward, especially in the heartland countries that we work in, governments are looking for flexible



ways of financing this and it is something we can work on, providing a service rather than an outright sale. Build, operate, transfer is becoming more and more important. Indigenisation is a driver in the markets we're in. They want the pride of manufacturing their own passports, so what do we do? We will build something in their sites. We will operate it. We will transfer it there and we will retain consultancy services, and the right to run it, in the country that it's in. It differentiates us from our competition.

International funding, what do I mean by that? The International Monetary Fund is supplying loans, which is driving particular behaviours, such as a push to have consistent bidding processes. That plays to our advantage: it removes the advantage that an incumbent might have, allowing us to play again. It broadens our scope in that marketplace.

Product authentication, now what is product authentication? Let's be clear. In the De La Rue context, it's about brand protection. Our key customer would be Microsoft. If you look at every Microsoft software product that you might buy, you'll see a label at the bottom with a barcode and a number and a hologram. That's from us. We supply that globally and have done so for the last 15 years. We supply brand protection to a lot of other large brand names as well, from whisky manufacturers all the way down to shoe manufacturers. Some of these came through the DuPont Authentication acquisition. That's about brand protection and brand recognition.

The other part is tax stamps. Tax stamps are like cash. They're something a manufacturer buys to show he's paid the tax and the product is selling, mainly in tobacco and alcohol in various countries, and the software solutions that go with it. I'll talk about the software solutions in a little while. In general, those are the markets we play in. This market in particular is extremely fragmented, multiple local players in multiple countries, giving us the opportunity to consolidate, because we have a global footprint and a lot of the brands have global needs. Okay, so those are the markets we're playing in.

## **SLIDE 21 – Common platform innovation in three areas**

The three themes: security features, software and design. Let me come back to these. Before I go here, let me talk about how we got here. We've always put together security features, but we focus primarily on the currency part of the business and a little bit on the ID. What's happened with the teams here is we've consolidated the terms. We've brought in common ways of working in common, platforms to work things through on. What do I mean by that? If you invent a hologram method for currency, we should be able to use it in ID and brand as well. You develop a common platform, common manufacturing methods and apply it across all three. At times, you segregate a particular technology for a particular area to enhance counterfeit ability, but not all the time. That's what I mean by common platforms: it's a common way of working that amplifies every pound we put into innovation.

To get our security features up and moving again, we've done two things. We have consolidated the teams. There's been churn in the team; 30% of the team is new. We've brought in new skills and new technologies to drive where we want to go. That's the journey we've been in and we're beginning to see results there with the product launches we're beginning to see. The two main areas where De La Rue leads in many areas is holograms. There are two types of hologram; one type of hologram, and Brian will be going into it later, we've always done. Lippmann holograms we did not have. Now we have it under our belt. We are one of the few vertically integrated suppliers of Lippmann holograms anywhere in the world. When I mean vertically integrated, we manufacture the material that is used for the hologram. That is rare. There are other people who make the hologram, but they buy the material in from elsewhere. We make the material; we know how to replicate it in volume and we know how to supply it into the marketplace. It has predominantly been used in brand, but we're going to expand it. It's already used in ID in one



area; we're going to expand its use in ID and brand. That's expanded our footprint in holograms considerably, giving us reach right across the technologies that exist.

Software innovation, what do I mean by that? Software was always the second cousin nobody wanted to know about in De La Rue. We did software, but not particularly very well. What we've done is taken all the teams and put them together. There's now a common software development team and Kevin will be talking about that later, in De La Rue, running common standard, running best-in-class scrum methodology to develop products. We've got an architectural team that drives common architectures. We've moved our software base from antiquated methodologies to new web-based methodologies and transportable software platforms. All of that's started to take place, and it's either embedded or moving forward.

Our methods of testing are enhanced automated testing methods, rather than manual testing methods. Our security is second to none, because it is a requisite. It's a given in our marketplace, from external validation of penetration testing, internal validation of penetration testing and external validation and code validation that we go through to make sure that, one, we are secure and, two, make sure that our customers know that we are secure. Those are the areas of focus we've started to move along with software.

Last but not least is design services. Design is something that straddles everything we do, yet we never actually pushed it to the forefront. We have probably the foremost design team in the industry, in any of the industries you look in, from ID to currency to brand. Why? Because we are vertically integrated. What do I mean by that? We design holograms. We design the note itself. We design the UV workings that go in it. Every single component is designed by us, including the watermark on the paper that it goes into. That is complete vertical integration. Why does that differentiate us? It means we can tie the design together, one for aesthetic reasons and, more importantly, to make it much more difficult to counterfeit, because everything sits together as one whole, with a layered security approach.

Design is a considerable part of what we bring to the table. Putting what it might bring to us in terms of token manufacture of software delivery, it also allows us just to provide a design service, even if it's a note that is being printed by somebody else. Into the SPWs, we'll be designing. Into state passports, we'll be designing. We've segregated it and offered it as a separate service. The advantage we have when we design is that our security features naturally fall into place, so there's a tale to this consultancy that we can bring along. It is an important part of what we already have, being refactored as a service and being openly offered in the marketplace with a methodology that will drive results.

## **SLIDE 22 – Product launches**

Product launches: as I said before, think it's very important we understand that products are not just about a point launch of something into the marketplace. It is about launching products that interact with each other that sit in a layered structure and a forward-looking roadmap. We've started to walk down that path. We've launched six products this year. We've got more new technology, new platforms, in our funnel than we've ever had before and those will work their way through the system and end up as new products, as time goes forward. We have over 1,600 patents in our portfolio. IP is not just about making the product; it's about licensing the product. We're agnostic to it. It doesn't matter whether we license it and somebody pays us a royalty for it or we make the product ourselves. The bottom line doesn't change; in fact, it might be enhanced. Fundamentally, it's about how we gain IP and knowledge and operating knowledge to be able to differentiate, as we start to move forward. There's a big focus on products and product launches.

That includes services. Again, we launched our first cloud service in Analytics this May. That was designed over the last 18 months. It mapped all our customers' security requirements and brings

significant advantage to what they've got to do and eventually to us, because it will help us remove the lumpy nature of some of the orders we see. Nikki will be talking about that a little further, as we go forward.

The other thing we are doing is combining technologies. There was a tendency to have a single technology as a security feature. By combining technologies that might already exist, you create a third, two and two making six. You end up with a third component that actually is more difficult to counterfeit, so we're beginning to combine technologies to give us an accelerated route to market as well.

### **SLIDE 23 – Differentiation by design**

Like I said, a multi-skilled team, about 50 people, not only look at how a product is designed, but how manufacturable it is. It's not just about designing something; it's got to be manufacturable in volume to the standards that are expected by our customers and our own internal De La Rue standards as well. It puts us in a unique position to be able to design and work with SPWs to show them how they can manufacture it effectively. That's another service we'll be offering, a service called ADAPT, that looks at manufacturability of a product and how we run it through optimisation for manufacturing. This is being done currently in a manual manner, but it's being more and more automated and we'll be in future modelling it. It's like wind tunnels for a car. You don't actually put a car in a wind tunnel anymore; 90% of the testing is done by modelling and we're beginning to move to a modelling method to do this. One, it'll help us. Two, it allows us to offer a service outside our current bands of services that we offer.

### **SLIDE 24 - Partnerships**

To be able to innovate, particularly in today's world, we have to work with external partners to accelerate route to market or combine technologies that we may not have. Gone are the days when everything needs to be invented here. It is about working with partners, particularly in the software area. There's no such thing as a competitor that's just a frenemy; people you work with you compete with, at other times, and you cross-license when you need to. The same applies here. In the last 12 months, we've signed three partnerships – one to come up with security features in polymer, and two in ID. These are important ways for us not only to bring new technologies into our domain, but to accelerate our route to market, and this is an activity that will grow as we start to move forward.

Now, I'd like to hand you over to Ulrich, who will talk to you about security features, and Brian, who will talk to you about holograms.

## **Security Features**

**Ulrich Walter**

**Product Director**

### **SLIDE 26 - Security Features offers an attractive, commercially available market**

Good morning, everyone. To introduce myself quickly, Ulrich Walter is my name. I've been with De La Rue for a little bit more than a year, so I'm part of the relatively new senior leadership team

that Martin referred to at the beginning, but I have 16 years of industry experience working for German, Swiss and US companies in the area of high-security printing. You've heard already Martin talking about security features. You heard Selva present to you about security features, so what is it really that's special about De La Rue and security features, you might ask. I'll come to a small and, forgive me, short definition of what we consider to be security features in a minute.

What's really different in De La Rue is De La Rue doesn't just do printing, like many other companies in the industry do. De La Rue doesn't just do holograms, as we've already referred to. De La Rue doesn't just do design of notes. De La Rue also does paper polymer. What I'm saying and what is really different here, outside all the other aspects that we've covered already and which we will be covering today – and I think that's something we can really be proud of here today – at De La Rue, for the last decades and for the years to come, we have the combined knowledge and experience from substrates, print, design and obviously also the whole integration and services to the markets we operate in. That is really, really cool for everyone to understand and that's really, I think, something our customers appreciate.

Now, when we talk about security features – and you obviously heard the terminology and some of you may be very familiar with that – just for those of you who may not be so familiar, possibly, what we talk about here is really features that you use in banknotes, ID cards, passports, but as well brand protection and tax stamp labels. Primarily, we're talking about holographic elements, foils you could say, and in the banknote arena we specifically talk about threads. Threads, you know all about them because you have them in your pocket if you carry cash, if you carry banknotes. You'll see on almost every banknote, and I'll come to a statistic in a minute, a thread. Right? Let's take a look at what's really happening in the market there.

As I said, banknote printing, of course manufacturing of paper and having the security features in the paper, integrated already before it's printed, plays an important market and is, by far, the largest part of our operations here, we can say, outside the ID space and outside the product authentication space. Now, as you see here on the left-hand side, we talked about 172 billion banknotes produced annually, roughly. That means that here we are operating in a big market and, actually, if you look at the spread of security features, you will see that 90% of all banknotes carry a thread. That is a real important element of that market.

Now, this doesn't tell you whether that's a low-value, mid-value, high-value or premium feature but, overall, you see 90% carry a thread, so obviously it is very crucial and important for us to focus as well on threads, but also on other technologies that I'm going to be talking about in a minute. When you take a close look at the thread market, and here this is the commercial market really, because a lot of the market is controlled by state manufacturing works, state paper works and state printing works, on the commercial side of things there are only a few main players, as you'll see here. De La Rue has market share roughly, according to our calculations of 8% growing actually. That's quite good to know. The first headline here for you: obviously it is very important to see it is commercially attractive. What do we mean by that? We have actually high margins in this segment of our business.

Is that banknote only? No, it's not just banknotes. It is that we can use what Selva talked to you about, the innovation and the product portfolio basically of our technologies and platforms. We can use them also in the ID space and in the product authentication and tax label. That is a synergy, if you want, which we have now started to elaborate and leverage really, so that we can cross-sell, but also offer our customers the benefits of some research development and experience specifically on the counterfeit side in other segments of the high-security printing market. There are other benefits for our customers.

The nice thing for us, if you talk about the commercial side of things, typically in specifically banknote and ID, you'll see that we have long-term contracts. What do I mean by long-term





contracts? Usually, they're five years plus. Sometimes it even goes up to 10 or 15 years. It depends on the contract, depends on the country, depends on the competitive situation sometimes of course, as well. On the product authentication side, it's a little shorter cycle, so you would say possibly below five years, but it depends on the customers of course.

Now, what has been referenced before already today is that obviously it's very important that you invest in your portfolio and you invest in your roadmaps, basically, which we have done. We have put an additional emphasis on doing that in the past years, which is really, really important in helping us do so and helping us to grow. Technology is not just technology. Technology also means that we need to create our own IP, because the IP actually is a barrier for competition not to enter the market easily, unless they invest themselves of course in their own research and technology. Also it means that we are protected because, sometimes, you could replicate and imitate an effect even on the product side of things but, if you have core IP in that space, it's going to protect your business and of course, in the end, also your margins. Again, remember there are high margins here in this area.

What has been referenced before as well is that design is a core element of our solution offering to the market. Why is design so important? We'll show you a few examples later on, so I'm not going to focus too much time here. It's important from a customer experience. A customer really lives and feels how he can interact with our design team – and Julian will be talking about that later – at any stage in the basically acquisition process, but also the production process. It's very important that we talk to the customers about integrating design with the security features, or vice versa. It's not just the multi-layer approach, but it's also the experience and public perception of the notes and the features.

One final remark on that one, because I'm talking about the public here, is in features it is important that, on the one hand, you have sophisticated technology. I'll be talking about here on this slide. You also need to make sure that the public, who are in the end our final customer, you could say, is still able to recognise if a feature works or not, or in which way it works. You can't make it too complex, although for a counterfeiter of course you want to make it very hard to counterfeit. That is a fine balance you will always need to think and worry about when you invest in your portfolio and your roadmap.

## **SLIDE 27 - Security features development is critical to remaining ahead of the counterfeiters**

Now, I've already touched on the aspect of counterfeiters and of course the investment here is critical, so that we stay ahead of the counterfeiters. It's what we call an arms race, really. If you look at this graph here, it shows you previously counterfeiting was all about printing and the way you printed a feature, a banknote for example. Now, it is more and more about a complex combination of various technologies in how you forge and, on the other hand of course, protect and make the security of your products right. Here, the number of different ways of combining counterfeit production technologies has increased significantly, specifically since the days when digital entered the marketplace. Digital printers and photocopiers changed the game dramatically here in this sense.

Also, we see that counterfeiters of course work across international barriers. They work across various technologies, because many of them are commercially available. Part of the success as well in security features is having invested in technologies that are not commercially available, because that protects your IP; that protects your customers from the counterfeiters. That's really about the combination here. That issue I've outlined here is really applicable to all three product areas in which we operate. That's quite clear.



Now, we talked about innovation and that has picked up. It's really, really also important for us to obviously show the success of the innovation pipeline and the roadmap to the market, not just because we want to be innovative, which we have to be, quite clearly, and we are quite good at being innovative. We also need to show additional benefits to our customers and offer them some solutions, which they cannot get elsewhere, or where we say we have an edge, because we can combine various functionalities, for example in the thread, which is not just about an optical effect, but also carries a machine-readable element. All of this combined needs to be presented as an overall offer to the customer.

## **SLIDE 28 - Continued investment in innovative features**

This year, just at one major conference in May, we launched two security feature products. Both of them you see here and you'll hear about a little bit later from my colleague Brian, just now. What have we done? This is just giving you a sample. You'll see samples actually later. Here, with the Kinetic StarChrome Portrait, what have we done? We have combined something likely every one of you has been aware of and has known how to use: a simple colour shift, a colour switch, in a thread. That's on many, many bank notes today – more than two thirds, you could say. We've combined it with a holographic element, which again is very well known by the public, but by combining it and bringing it together in one feature it makes it harder to counterfeit and more complex but, in the same way, it is intuitive.

That is really also very critical for the success of features. And, by the way, of course, it can be very nicely integrated into the overall design of a banknote, because you can replicate the motifs – for, example the portrait of your President or King or whatever it is – in the thread even. It is very obvious that this belongs to the banknote, ID card or passport.

TrueImage, just to be very brief on that one, has launched for our polymer substrate and is really a holographic feature which presents a three-dimensional image and effect and actually, also, a kind of movement effect – so very nice, very sophisticated but attractive to the eye. And that's what I think the market has been looking for. Again, as I said: complex but easy to understand at the same time. And that's why we've invested in it and we will keep investing in it.

Here I'll hand over to Bryan.

## **Holography and Security**

**Brian Holmes**

**Chief Scientist**

## **SLIDE 30 - Holography in De La Rue**

Good morning, everybody. My name's Brian Holmes, and I am Chief Scientist at De La Rue. Just to give you some background, I've been involved in holography and security features for nigh on 20 years, so I've been around for pretty much the entire length of the security-feature industry.

Just to give you quick historical context, holography was first used as a security feature back in the early 1980s by MasterCard and Visa. The catalyst for that was two events, really. First of all, the advent of relatively affordable high-powered lasers – and on the right-hand picture there we

have a snapshot of one of the lasers in our laser table downstairs. Effectively, you could think as holography as laser photography, in very simple terms. So, lasers are essential.

The other event, really, was an invention by a guy called Professor Stephen Benton – that's his picture on the right, a very 70s picture. He was really the true pioneer of holography, and he discovered a way of making holograms visible in everyday lighting. Prior to that, holograms were only displayed in galleries using specialised laser light sources. He did that by sacrificing the vertical three-dimensionality of the hologram and replacing it with rainbow and colour changes. So, Benton holograms are sometimes known as rainbow holograms, and actually they are the predominant form of holography within the industry today.

As I said, it's over three decades now since holography was first used. I think it's fair to say that it's been the most pervasive form of security feature. It basically has made a big penetration in all the security markets. I think a key factor in that is actually it offers great design versatility, probably second only to security print. The other thing is it can be very economically manufactured. The way we replicate it is very akin to printing. Also, the structure itself is quite simple so it's very easy to kind of convert it into different product lines. It's very, very versatile.

Those are the kind of three key things. The other thing, as well, is if you look at the history of holography and security, it almost reinvents itself every decade. So, every decade you see a big change in the format and style of it. And I think that's a trend that will continue. With improving manufacturing capabilities, design capabilities and improving science, you'll see there's a constant refresh of the technology.

So, I've been involved, as I say, quite a long time. I probably originated over 1,500 holograms for different security markets. What I'd like to show you in the next three slides is just an overview of some of the holograms we've created over the years.

### **SLIDE 31 - Currency examples**

So, these are some of the examples used in currency. On the left-hand side, at the bottom left, we have one of the very earliest holograms we did for Poland, for the Zloty. Above that we have a very wide stripe, which is one of the earliest stripes we did, for Albanian. On the right-hand side, we have two images from a Clydesdale series of holograms. Actually, we are one of the few companies that puts three-dimensionality into paper-banknote holograms, so it's a stand-out thing.

In the middle, we have our first hologram that was used on polymer banknotes. This is for Gibraltar. I think, as well, if you look at that middle one, for me it shows a lot of the attributes of holography. As well as being a sort of technical feature, with good design it can be made fine art as well. It is this artistry, the strong visual appeal, which is why it is so resonant.

### **SLIDE 32 - Payment card examples**

Just some examples of holograms we've made previously for payment cards. Obviously, the Visa dove – the bottom left-hand side is a dove image. I know that one very intimately, because actually I was responsible for sculpting the dove there, which actually is about this size in reality. And that one there actually has a slight broken wing on the left. There's a small Allen key propping it up at a right angle – but that was a bit of a labour of love.

On the top right, we have what was called the 'Amex blue' hologram. It didn't present an image, but what it did present was a very intriguing optical effect so you could view at all angles. And in the bottom right we have a hologram we did for Lloyds TSB, which was a sort of running horse. The horse appears to run across the width of the hologram as you tilt it left to right.

**SLIDE 33 - Product authentication examples**

Finally, we have some examples from product authentication. The top left was one for the FA. We've got one for FIFA in the middle bottom, and also one for UEFA. On the bottom left we've got tax stamps, which ran for many years, which were basically on Johnny Walker whisky labels, and then finally one which is a bit more cerebral, which was for Cambridge University.

**SLIDE 34 - Purpose and function**

At the risk of stating the obvious, the *raison d'être* for holograms is to protect against counterfeiting. That counterfeit threat became more prevalent in the late 1980s and early 1990s with the advent of digital reproduction technologies, reprographic technology and digital printing, and these days the advent of low-cost scanners, digital cameras and digital printing. So, what we needed was to put something on the security document that would resist simulation by digital printing.

Holograms and all security features do that by providing an image that changes appearance when you tilt it, so it actually changes colour or shows some movement effect or graphical form. So, this optical variability is at the core of all security features.

Holograms, like most security features, are first and foremost a public recognition feature. That is really important to understand when designing a hologram, because you've got to engage the interest of the public; you've got to create effects that are very easily perceived and recognised and very memorable. If people don't look at the security feature, don't look at the hologram, it doesn't really matter how technically secure it is. Getting public engagement, public interest, is priority number one.

**SLIDE 35 - Classification of holograms**

As Selva mentioned earlier, there are fundamentally just two forms of security holograms within the industry. There are embossed or Benton/rainbow holograms. That is shown on the right-hand image. Those holograms are most predominant at the moment. They typically have a metal reflective coating, so they appear silver and change to a rainbow of colours on tilting. And the other form is a Lippmann hologram, which is shown on the right-hand side here.

If you like, under the bonnet they work in very different ways. In an embossed hologram, the holographic information is a tiny microscopic ripple pattern that sits on the surface of the hologram, whereas in Lippmann it sits as part of the reflective layers within the volume. So, they fundamentally work in very different ways, and that gives them a very different appearance.

The key thing for us, from De La Rue's perspective, is that both our form of embossed holography and Lippmann holography are great mediums for three-dimensional imagery and, actually, one of the coherent things we have done over the years. Three-dimensionality is something that always resonates with people. It's very intuitive; it's very easy to identify.

**SLIDE 36 - Advanced embossed holography**

Our form of holography is Benton/rainbow holography, which we have evolved over many, many years and taken to a very high level. In currency alone, I think we've supplied over 3 billion hologram units. Throughout that period, there has been constant drive for innovation. A lot of the image effects we have are patented. We have over 200 patents covering this origination platform.

If we look at this image – this is something Ulrich mentioned earlier – this is what we call Truelmage. Actually, when we did a survey a couple of years ago about what the features were



that people liked to look at and we spoke to our customers, they identified three things: moving colour effects, three-dimensionality, and photorealism. People were engaged by photorealistic imagery. So, this image, which we call TrueImage, has everything. It's got three-dimensional effects. We've got a real barn owl, actually rotates its head as you turn the hologram. It actually is a real barn owl, photorealistic. We've got movement effect in the moon, and we've got moving colour.

So, it has all those things, all those three key feature effects. But they're brought together through good design in a very aesthetically harmonious way. Effectively, they really add value to the sense of the banknote. I think this is another very important attribute of holography, or all security features. They are a security feature, but it's also important they increased the perceived value of the security document. They make it look more valuable; they bring aesthetic appeal.

One of the other things with the advent of polymer is, actually, it's a very, very good medium for 3D holography. So, actually, holograms were first used on plastic cards, which are very smooth and very rigid. When you go onto a banknote, the surface is much rougher. You get some degradation and diffusion effects. But on polymer, you're able to put back in all the attributes of three-dimensionality and colour, so it's a great match-up, 3D holography and polymer.

### **SLIDE 37 - Enhancing internal imaging capability**

One area we haven't exploited a lot in terms of originally creating our own holographic masters is in the area of ID. And if you look at most ID cards and passports, unlike other areas the hologram has to be transparent, but it sits over all the personalisation data for the user. To make it transparent, you have to remove this reflection-enhancing metal coating. So, the hologram suddenly becomes much less bright, by a factor of 10.

Now, what we find is that 3D effects probably aren't quite bright enough to be visible, so what you have to do is focus more on two-dimensional effects. What we've done is we've invested recently in a new form of origination system, which actually produces very high-brightness holograms and also very high resolution. It does it in a very fundamentally different way. So, with classical or the embossed rainbow holography, you are getting a big helping hand from science, if you like, in terms of the way the micro-structure is created. Here, you have to individually engineer each tiny pixel of hologram. And what that does is it gives you a challenge in terms of the control you need to provide and the mathematics, but also it gives you great control and precision.

So, the system we've got is not only very high brightness but it's also extremely high resolution. It's got a resolution of about 100,000 dpi. As well as producing very strong level-one features, we'll also be able to produce stronger forensic and level-two features.

So, that will greatly increase our options, if you like. It will also give us an in-house capability for doing these transparent holograms you use on ID cards.

### **SLIDE 38 - Izon® Lippmann Holography**

Finally, and most importantly, is Lippmann holography. Lippmann holography is really the ideal platform for three-dimensional imagery. So, the embossed holograms I talked about earlier – you can see three-dimensionality in the left-to-right axis, but you can't see it vertically; you just see colour change. If you look at this video of a Lippmann hologram, you see that not only does it show you three-dimensional effects on horizontal tilting, but also in vertical tilting. And this one here actually gives a very simple key of one, two, three, four. You see each of the dots on each side. So, actually, only Lippmann holography can produce this full parallax three-dimensionality.





The other great attribute of it is that it doesn't change colour like an embossed hologram, but actually it's very, very viewable under all light conditions. A lot of security features, including embossed holograms, don't work as well under diffuse light. This form of Lippmann holography basically is invariant under all lighting conditions.

It's very different, as I said before, because the holographic information is captured within the volume of the material in these microscopic partially reflecting layers. Unlike embossed holograms, it can't be manufactured or replicated mechanically. It has to be done optically. It's a bit like the industrial photocopier: you have an overlying material that goes over your master image and effectively it's scanned by a laser and you copy from the master onto the overlying material. It's very, very specialised and the technology we've bought is pretty much unique in the industry.

As Selva said, the materials as well are very proprietary; the manufacturing methods are very proprietary; and the effects are very unique within the industry. By having the two forms of holography in house, we are the only people in the industry who actually have those two platforms fully integrated, and that gives us great potential going forward.

## **Integrated Design**

**Julian Payne**

**Creative Director**

### **SLIDE 41 - Integrated, end to end security design capability**

Morning, everyone. I am Julian Payne. I'm the Creative Director here. We've heard a lot of talk about design this morning, so I'm going to kind of lift the lid on it a little bit about what we do, how we're organised, the methodology we use, how we engage with our customers to kind of bring it to life, I hope, a little bit.

I may dress like a Victorian, but I run a 21st Century design studio. And we deal with some of the most cutting-edge materials science out there in the industries we work in. I will give you a bit of insight into some of those things as well.

So, a bit about the design studio – I think Martin mentioned it earlier. There are around 50 of us in the Group. It's split broadly 50/50 in terms of creatives and what we call technical experts. What do we mean by that? The creative team are a bunch of designers who really will take a blank sheet of paper right through to a prototype concept/design for a customer, so we will work in banknotes, ID, brand or product authentication.

So, they're able to do all of the portfolio areas, but, importantly, they're also able to design in any of the media we choose. So, that could be paper for bank notes or passports, polymers, polycarbonate, holography, security features or threads, as we talked about the last session, as well as the print techniques, which obviously involve a range of specialist security inks, which all have different properties. So, right from the start of the process we're thinking about manufacturability.

The difference between perhaps the design that we do here and maybe a graphics house is that we are designing products, and this is a product design group. If you think about a UK passport, for example, that is guaranteed to last for 10 years. That is down to the materials we use and the



way that we've designed it. We make something like 7 million UK passports a year, so the manufacturability of that to ensure the waste levels are low, that it can be efficiently manufactured, and, important for our customers, that they are identical – because that is where you get your security. You don't want slight differences in each one, because that is a kink you want to avoid.

So, that is part of the design process as well, which is why we start with a built-in quality methodology right from the start, right from the concept design through.

That is the creative side. We then move into what we call technical design. In that group our engravers typically work. So, we have six engravers. They will create the portraiture that goes onto the banknotes, for example, most typically some of the vignettes, so that's the sort of landscape background you get on the back of notes.

And also there's the origination team, so technical design. That is where we move into what we call 12,000 dpi, so a level of detail that a commercial printer cannot reach. And the notes are originated, and they are also proofed. In the design studio downstairs we have a proofing hall. Our customers will regularly come in to see the proofs produced and sign off the proof, because that proof is the closest thing we are going to see before it goes into mass manufacture, an identical copy of what they are going to see – and they sign off against that.

That is unusual in this industry, in the sense that we can go end to end, every product discipline, every technology discipline, right from a concept through to a prototype. It allows us, then, to mix and match. This is the idea Selva was talking about earlier in terms of a platform approach. Design is a platform. You can put designers onto passports one day, onto banknotes the next, onto brand after that. And any media we want to design, we can design here. That brings integration; it brings a better relationship with the customers, because the customer can see more of what we're doing. I'll talk more about that as we go through these slides.

## **SLIDE 42 - Leading design capability**

Much has been said about our scale. We design more banknotes than anybody else. And I'm not going to repeat that, but what's quite interesting in this graph here – roughly, these are denominations out in the world today. There are over 1,100 denominations in the world, of which just shy of 400 we design, both for the central bank market but also commercial bank issuers – think of the banks in Scotland: RBS, Clydesdale, Bank of Scotland, for example. There are commercial bank issuers as well, who have rights to issue notes. We design for them.

Also, state printers. A state might decide to, generally, print its own notes, but they may come to us for design services. That's part of the proposition we put out to the market: we can provide the design consultancy or even they design themselves. We are doing that for a number of state printers at the moment. And we are able to do that. Therefore, the state print segment is an available segment for design services, which is sometimes different to managing the whole print cycle for a customer, which then allows us to think about what security features, what types of substrates, polymers or paper, that we can provide and design for these state printers.

I picked up design just over a year ago. My background was in product, product management and product design. And I think design has always been very, very important in the banknote industry. You know, you'll see some stuff from our archive when you have lunch, and you can see there are some glorious designs from the past.

So, the graphical representation on notes has always been really important, but the productisation of design and the part that it plays in how we engage with customers, how we design the right feature and the right IP into those notes, is something we want to refresh and look at again.



So, we've really looked at how we've positioned design as a series of modular services. So, it might be for a central bank we're the end-to-end partner: we'll design the substrate, the features, the print, everything and manufacture it for them.

For the state printers that I was talking about earlier, we can provide them services around the design, but it might be around plate-making or even just proofing. They might want to do a lot of it themselves and then come to it for the proofing or the design for manufacturing capability. A lot of them run state-owned print works, which are not necessarily the most efficient in the world. A lot of the skills we have in our design studio and the technical services of the design studio can provide them insight on how you might want to design the notes to get a better through-put on your machines. Given that we design 373 denominations, we have a really good view of what works really efficiently as a design from a manufacturing perspective and what is more troublesome. We can give state printers that sort of advice and consultancy on those sorts of services as well.

So, a modular service is kind of how we position ourselves in the market. As I say, we service the entire market, state printers and central banks together.

### **SLIDE 43 - Customer-centric design approach**

The other change that I think is really important – that has been a slower evolution over the last couple of decades – is where the customer sits in the design process. Coming from a product background, they sit right in the middle. The engagement with that customer is fundamental. There are obviously business benefits to that, because you have customer engagement and therefore it creates a more partnership approach and they feel like they've been part of the design.

But there are some really practical ones as well. If you think about the head of issue at a central bank or the man or the woman who is going to head up the new passport project, they've got political scrutiny, they've got taxpayer scrutiny on them. The press will be looking at the decisions they make about even what figurehead you are going to put on the banknote or what choices of picture you're going to put in the passport. It's very politically challenging for them.

Typically, they are an experienced civil servant or experienced central banker, but it will be their first time in a design project. That is difficult, because you just heard the download on holography this morning. Imagine that with the same level of detail coming at you around substrate choices, print choices, around how much all this relatively costs. It is quite a minefield for them to navigate, and actually the design studio and the role of the designer is to help break that down.

It should be quite an enjoyable experience, actually. I have presented it like it's terrifying. On one hand, it is. On the other hand, of course, you are heading up your country's major national infrastructure project to launch the new currency; therefore, it should be something you are proud of and it should be something that is going to represent you – but equally we can guide them. And that's really, really important for the design team. This is where the design choices we help them make will help them write their business case. 'What is the ROI on this? Why should I choose polymer versus a paper substrate or a different durable substrate that is varnished, for example? What security features should I choose? How do I choose them? What is the methodology by which I make the selection I do?'

We are able to work with them to give them that confidence, to help them build their business case, to help them build their project plan and to deliver on time for their objectives of hitting the best value for taxpayer, but for us ensuring we've built the relationship that builds the long-term relationship with the customer and long-term contracts.



We have modular services and the customer is at the heart of the process. The last change is around evidence. You could accuse this industry in the past of saying, 'This is brighter and shinier than the thing you had before. You should buy it.' And you could accuse it of being a bit of a beauty contest of security features.

#### **SLIDE 44 - Evidence led design methodology**

Nicky is going to talk a little bit later about DLR Analytics, but the use of data both driven from circulation evidence, which DLR Analytics delivers, as well as getting closer to customers – we often work closely with them on design workshops to understand the end-user perspective on a banknote or a passport, how it's going to be used – is vital now to modern banknote design and how we deploy that at De La Rue.

So, we will understand from the analytics data what notes' lifecycle is and, therefore, what design strategies you need to deploy on that bank note to make it last longer, for example. We will understand the counterfeit challenges, because we have an anti-counterfeit group here who will do analysis on notes. We will understand how your current series could be compromised and, therefore, what other features you need to bring in to defend that note.

So, it is about giving the customer evidence. If you think back to the customer being right at the heart of the design process, a central banker, like you guys, is data-driven, wants to see the evidence, wants to see the facts and wants to understand it numerically. We can help them deliver that, because you say, 'The analytics data shows that these notes have got a note life of x. We need to increase it by y. You should think about varnishing your notes or maybe moving to polymer.' 'We see counterfeit in your neck of the woods around what we call composite notes, for example. We can design the face of the note in a different way that can impede those sorts of counterfeit strategies.'

It is about bringing evidence to it. The other piece is about the end users. How do people use it? People in sub-Saharan Africa will use their money in a completely different way to how we use it. It is a little bit of anthropology, perhaps, but it is important, because how you fold a note and how you store it – pop it in your Kapilana[?] or you put it in a brassiere, for example, real case studies – works really differently to how we fold it in Europe or how a guy carries his money in Taiwan, completely different. And that will have a direct impact on the note life, and therefore your ROI, and, as a central bank, what you should be putting onto your bank notes.

The other one is around how the threat level changes. So, integrated security is really important. I was asked recently at a conference, 'What is the easiest passport to counterfeit?' And it's a bit of a non-question. It's, 'What is the most desirable passport to counterfeit?' And the reason we work so closely with HMPO, HM Passport Office, and they have one of the highest-spec passports in the world is because that is a desirable passport to counterfeit, because you can get a visa to many, many countries. Other countries are less desirable, and therefore designing the defence strategy that's appropriate for the country and appropriate for their threat level is what we are about. And that is about building evidence into your design so they are making the right choices and the best-value choices so we can build the most robust design.

Then the team really have to get their heads around the materials I talked about earlier: what is the speciality ink? What are the security features we are going to put into this and deploy it? One of the great things about De La Rue's portfolio is that it is very, very broad. Some people say that it is a bit difficult, but given the use cases – we design 373 denominations in every different part of the world. That means a whole bunch of different use cases. We design for the globe. We're not designing just for the United States or just for eurozone. We have to deliver everywhere. Therefore, having a broad set of capabilities means we can deliver the right set of capabilities for



our customers wherever we are. Therefore, I need designers who are able to turn their hand to any of these capabilities.

Lastly, which I touched on earlier, another key area is manufacturability. Over a 5-10 year period, we are likely to make millions or billions of these products. We want to get them as efficient as possible through our manufacturing process. We want to be able to use materials we can source in multiple places and get the best cost. All of those things are where it gets crunchy in the design studio, because we're having to balance the commercial needs of the customer, the manufacturability and margin desires within De La Rue and bring that altogether in an award-winning design for the customer.

#### **SLIDE 45 - Integrated product design**

As Martin said, after lunch we've got a whole load of samples and goodies you can come and have a pore through downstairs, but I'll give you one example of what this integrated design thing means that we keep banging on about it.

This is a Seychellois rupee. They went into circulation in December last year, so it's a relatively new note. The security features you were hearing about earlier have got two jobs. One is they are instantly recognisable to the general public. If you think about some of the countries we work in, you want the note to be almost self-authenticating. It is a vehicle of trust. You want to pick it up and touch it and understand it. You want to see it and trust that it's secure. How do you do that? Well, you have some clever security features; that is one. But the point of an integrated design studio is that you can build them in a way that educates the public and allows you to authenticate the note quickly.

One of the tricks, if you can call it that, we use is narrative, which is a sort of very basic human emotion that we respond to. So, here we've got a green tree frog. The theme of the Seychelles notes was their unique biodiversity. So, these creatures, flora and fauna, only exist in the Seychelles. So, that's a nice theme to start with. It's a theme we see increasing, actually, a move away from humans to flora and fauna, for a bunch of political reasons as well as what countries feel better represents them.

Here we've got a tree frog. He appears within the Gemini, which is a De La Rue security feature ink. So, under UV light he appears here. He appears in the intaglio, which is when you feel a banknote you can often feel the sort of texture of it, the raised ink in the intaglio. But he also appears in the Kinetic StarChrome thread. He is looking at you. So, in these ones he is side on, but here he is sort of peeking around – there are his two googly eyes – looking at you. And this is designed in microns; we'll have some examples downstairs so you can have a look at them.

But, back to the public education piece, these are new notes. How do you know they're a new note: because you can see the frog three times in it. We play similar tricks often with the watermark, the hologram or the thread. It is the combination of those things that gives strength. If you sourced those separately, you would not get the cohesiveness of design nor the cohesiveness of manufacturability. And that's what we can bring.

So, it's that surety that we bring by designing it all in-house. We know how we're going to manufacture it. We can secure the note or the passport and deliver an efficient manufacture. The combination is the outcome we're really trying to aim for – as well as delivering what the customer loves, and a design experience they feel part of and they feel has reflected their country or territory in a way they can be proud of.

The other neck of the woods is a little bit on passports, where often materials science and anti-counterfeiting need all come together. This is called a continuous biodata page. I'll show you





when you come downstairs after lunch because it's probably easier to pull a book than look at a photograph.

But we work closely with national fraud document units all around the world. The NDFU is the UK's one. All of them tend to say the biggest problem or challenge they face with passports is adulteration of the biodata page. So, that's where your flattering mugshot and your personal details are typically kept. What counterfeiters like to do is unpick a book, take all the pages out, put in a new counterfeit biodata page, sew it back together and off you go – and you can go and travel the world. So, it's the most picked on part of the book.

Under advice from experts outside of De La Rue, working with them, we developed – De La Rue IP – a continuous biodata page. The data page is now adhered to the back of the book – it's quite a simple approach – with watermarking in it, so you can't take it apart. So, in short it's a tamper-evident document. So, whoever tries to take that page out, it will fall apart; it will rip the book apart. If they try to attack this piece, it's got a holographic laminate on it, which Brian's team would make. Again, if you try and break that apart, that will break the front of the book apart as well.

It's about taking customer insight, customer knowledge and market demand, working with our materials science colleagues here at De La Rue to develop something that delivers De La Rue IP into a world-class design.

That's the other side of what we do in terms of new technology. We are there mixing the existing portfolio of stuff in a way that end users and central banks need for the right kind of return, and here we are working on the cutting edge of new technology, bringing that to life for our customers.

That was a bit of a cook's tour. It's easier if you come downstairs and I can show you the picture. So, I'll pause now and hand over to Kevin Fraser, who's going to talk about software. Thank you.

## **Core Software**

**Kevin Fraser**

**Software Engineering Director**

### **SLIDE 47 – Digital solutions**

Good morning, everybody. As Julian said, I'm Kevin Fraser; Software Engineering Director at De La Rue. I've been here for six years. What I'm going to talk about is some of our core software products, our three main software products, as well as just elaborate on some of our capability.

So, the software-engineering function in De La Rue, which Selva alluded to earlier, when I first joined six years ago, was primarily focused around our identity business. We had a legacy platform called MIDAS that we had rolled out in around about 30-40 customer sites globally. Over that time, we have broadened the software-product portfolio, and very recently we have just launched DLR Analytics. Analytics is the only off-the-shelf banknote data collection and analysis platform that is available in the market today.

We have three core software products. Each one underpins a particular stream within our business.



I'm not going to steal Nikki's thunder and will talk about it only briefly now. But DLR Analytics was designed from the ground up to be hosted in the cloud and also designed, again, from the ground up, as is a common theme throughout today, to be very, very secure.

We have DLR Identify. DLR Identify serves our identity business, as the name suggests. It facilitates data capture, work flow, authentication and personalisation of tokens. And when I say 'tokens', I'm talking about passports, driving licences and ID cards. It also allows the capture of biometric data, including irises and fingerprints. We can do ten-print scans etc. And then we can deploy that information onto digital token, and we can do it securely.

So, the UK passport is an example. We recently upgraded to supplementary access control coupled with elliptical curve cryptography, and we delivered that capability into the UK passport. DLR Identify is the platform that makes that possible.

And DLR Certify is our software platform that serves our product authentication and traceability business. DLR Certify enables our customers, governments and authorities, who want to track tax revenue to order groups of tax stamps, where we can then manufacture them within our facilities, ship them out, apply them to a product and then have local government, using mobile devices, to scan and track those products out in the field.

What this translates into is a tax stamp appearing on, say, a one-litre bottle of vodka. And a tax inspector or customers individual can actually scan that QR code on a mobile device, a standard mobile telephone, and it will tell them, with our software, whether that's a legitimate tax stamp and whether it's on the right product or has it been applied to a half-litre bottle or whatever that may be. So, at the moment we are primarily focused around tobacco and alcohol.

I also just want to talk to the theme with regards to capability within De La Rue. We have been on a significant journey over the last two or two and a half years, to such an extent that these are our three core platforms. We have been amalgamating and developing the capability within the software team to such an extent now where we are pushing architecture, designs, patterns, secure features and capabilities from one platform to the other and back again. As the technology evolves, as vulnerabilities evolve, as threats increase, we are moving our technology between these three platforms.

We have also spent a significant amount of time focusing on our own internal teams and changing the culture and types of software teams we have. Previously, it was run as individual software teams, little pockets of technical capability around the group. This has all been amalgamated under the innovation and technology function now. We are one single team.

But one of the challenges Selva gave me two years ago was to start creating a flexible development service, because our business could be a bit lumpy and because sometimes contracts could take a while to win. We are not able to run a huge bench of software individuals. What we could do, though, is create a very strong core of individuals who understand our products, understand our technology and understand our capability, while at the same time creating a flex capability that can ramp up and down very, very quickly depending on what we need. We've done that offshore, but it's important that we retain the core knowledge inside De La Rue.

Able to deliver scalable customer solutions? As I said, the DLR Analytics was the first solution designed to be cloud-hosted, so we've partnered with one of the world's largest hosting solutions providers to host the DLR Analytics product. That gives us a global footprint to match our customer base. At the same time, because it's hosted, it's in the cloud, it gives us the ability to ramp up and ramp down that capability in line with our customers' demands. And multiple partners, multiple geographies. We don't build it all in-house. Obviously, we go out; we partner;

we identify technologies that we want to bring in, technologies that we believe will add value to our customers, technologies that have been tested and are secure, and then we look to see how we integrate those with our products. We've got a number of these different partners around.

#### **SLIDE 48 - Digital solutions**

And the last point I wanted to talk about is the client landscape being increasingly complex. So as our customers are primarily governments and central banks, they race to deliver new services and access to their services, to government services. The landscape that our customers are operating in does become extremely complex. At the same time, we have to be able to provide solutions that fit and meet into those environments, so solutions we can parachute in; solutions that actually meet the challenges our customers are facing. If we look at data capture, there's a big drive towards capturing biometric data. That's integration with various devices from different manufacturers, and that's something, within the labs, we look at quite a lot, understanding what we can use and what's going to be of benefit to our customers.

Banknote features, we also – and this talks to the analytics product – we developed our work with cash sorting companies to collect data on how components, to Julian's and Ulrich's point, perform within bank notes: how are they performing over time? What's the level of degradation on those components? And we're able to collate that data and bring it into our estates for further analysis. Unique identifiers – what I'm referring to there is primarily the likes of QR codes on tax stamps, and if you've ever seen a tax stamp, there's not a lot of real estate on it, and trying to scan a six by six mil tax code with a standard mobile phone can prove quite challenging. But it also gives us the – as mobile phones and their camera technology improve, it also gives us the opportunity to start exploring what covert features we can start capturing using standard optical technology.

Interoperability – we have to deploy our systems into sometimes legacy customer estates. Our customers have invested heavily in their real estate, in their infrastructure, in the systems they're using. We have to be able to provide solutions that are able to connect easily and share data and services and messages with the systems we're deploying into, or the environments we're deploying into, and no two are the same. Every customer has a different environment.

Security – common theme in terms of what we do. Every solution we build, every solution we ship, we make sure that effectively, we employ third parties to ethically hack our solutions. So we have them pen-tested, and we have them ethically hacked. On some instances, we will also employ companies to actually do forensic analysis of our code, which is crawling over our software code to identify any potential vulnerabilities in that code before it is shipped. It is an absolute given that our software has to be as secure as we can possibly make it before it is shipped, especially given the data we are handling and customer sensitivities to any potential breaches of that data. And last but not least, we're also able – based on the architecture and the frameworks that we've adopted, the patterns we've adopted within our software, we're then able to very easily start customising our software to meet the different needs, deliver different features, integrate with other hardware products.

So that was a bit of a Cook's tour. This afternoon, I do believe you've got demonstrations of all of our software products, so you can actually have a look at them, push the buttons. Any errors pop up, I won't be around, but – no, absolutely. Have a look at the software products; let us know what you think.

Okay, I'm going to hand over to Nikki to talk about analytics.

## **DLR Analytics**

**Nikki Strickland**

**Product Manager, De La Rue Analytics**

### **SLIDE 50 - DLR Analytics™**

I'm not sure if I'm allowed to say that we've saved the best for last, but I'm biased on this one. I'm Nicky Strickland, and I have the pleasure of being the Product Manager for De La Rue Analytics. Today, I'm going to take it through what it is and how we got to it, and later on this afternoon you'll see demonstrations of the products as well.

We launched De La Rue Analytics at the Currency Conference in May this year. So in our sector, there's one major currency conference every year, and that's where we launched Analytics. Since then, we've had 53 central banks who have signed up to use it, and that's approximately a third of the market. Of those, two-thirds are typically De La Rue customers; another third are not.

De La Rue Analytics is our analytics platform. We do data analytics and we apply mathematical models to central bank data to help them understand metrics around their cash cycle and how their cash cycle is performing, as well as their bank notes and how long their bank notes last for, and that feeds into factors like forecasting as well. It came about because we realised that central banks were repeatedly asking us the same types of questions. We get questions – 'How do I know if I move from polymer to paper that my bank note really is going to last longer?', or 'If I pay extra for this varnish on my bank note, how do I know I'm going to get the benefit from it?' We also get fairly frequently, 'What are other central banks doing?'

For a lot of the questions that they ask, there's different ways you can answer the questions, and here there's an example of various sorting machines, and the industry typically talks at this end. Big Data has captured the imagination of our sector, but I imagine many of you will talk outside of the currency sector, and actually the currency sector's relatively new to things like Big Data and data analytics, and relatively behind many other sectors. So even the very small number of central banks who have invested heavily in this area, they acknowledge publicly that they have a long, long way to go and it's still at the early stages. The vast majority of central banks have not invested in this area, and they're still starting to get their heads around it, or prioritising elsewhere.

### **SLIDE 51 - DLR Analytics™**

So we've developed these mathematical models and we've proven that they give valid insights, and we've done this off aggregated data. The philosophy behind De La Rue Analytics has been to provide a solution that is accessible to every central bank around the world – so we've set the price to be affordable. We've deployed it via the Cloud in the way that Kevin's talked about, so that every single central bank can access it. So of the base, even the central banks who can't guarantee electricity every single day of the week, when they have electricity and access to the internet, can get into analytics.

These are the areas that analytics can start to drive. So you can start to maximise your production efficiencies. You can start to forecast bank note demand better. Circulation quality – so how grubby or how clean your bank notes look in circulation. The logistics around it – are your notes moving through into cash cycle efficiently, or are they stuck in local circulation loops that mean you, as a central bank, never get to see them again? And actually being able to make fact-based and data-driven decisions around the specification of your bank notes.

**SLIDE 52 - DLR Analytics™**

Now, the majority of the work we've done to date is in this area, but while we've been evaluating the product and developing our capability, we've done work in these areas, and we've developed the capability and we know what we need to do to launch things. So this is your first snapshot of De La Rue Analytics, and you will see the demonstration later. So what you see in this graph here is bank note lifetime over time, and this data here is actually made-up data, but it's very representative of about 50% of the central banks that we have data for now. So if the specification of the bank note doesn't change, and if there's no external factors that change, we typically see the bank note lifetimes just fluctuate along a level value over time.

At the point where the bank transitions to a new family, or upgrades the durability spec, we typically see a spike like this in lifetime, and the spike happens for two reasons. So one reason is when you're in a steady state environment, you have a mixture of old notes and new notes in circulation. When you decide you're going to get a new specification out, the central banks will typically pull back the old notes and they'll push out all the new notes, so you get part of the spike because suddenly, there's 100% new notes in circulation, or a very high proportion of notes are new. But you also get a spike if you've increased the durability specification.

So what tends to happen over time is you get this spike, and then it starts to level out and it settles down at a new bank note lifetime. So here's two examples that I've anonymised: so here, stable note life; issue of the new, more durable specification; comes back down. In this example, it's just starting to settle now, we can see, into its new bank note lifetime value. This example here started low down, and it's stabilised for a number of years now, but this is really interesting for us, and it's really useful for our customers because it helps with the forecasting of bank note demand. So typically, central banks will think about how many notes they need in circulation, and they think about it in terms of what's happening to the economy, and they will know that much better than we will. They will know how they think the economy's going to grow, and proportionately, how many additional bank notes they may need to drive that growth.

However, 70% to 80% of bank notes, on average, are needed to replace old notes that have worn out in circulation, and the majority of central banks – actually, the majority of central banks do not measure the bank note lifetime and do not think about it routinely, because they don't necessarily have the analytical departments, and so they've not typically thought about things this way. So in these examples, typically the expectation is we change to a new, more durable specification, and we should stabilise relatively quickly afterwards, whereas actually, transition period can take a number of years. And if it's taking a number of years, we can use the data behind analytics to say how this is going to impact the bank note demand during that period, and we can also use the data we've now got with analytics to help central banks predict how long transition periods will happen. So it means we're in a much better position to help predict when the next bank note demands are going to come in, and working with a central bank, they also understand that to a better level.

**SLIDE 53 - DLR Analytics examples - impact of external change on volumes**

Here's a few examples of some of the things that have come out of analytics. So in this example here, the central bank's been in a reasonably steady state. They've not made any changes to their specification, but at one point in time, the public transport fare changed – so the price of that public transport was the same as this denominational value. And what you can see, if you look at the gaps between these points here, compare it to there, the growth of this note – the demand of this note – has accelerated, because suddenly it's gone from a note that is used occasionally to it's being used all the time on the public transport.





And this is something that wasn't really known to the central bank, so we had questions around 'Our notes seem to be wearing out a bit more than they used to. Is there something that's changed with the specification? Is there anything we need to worry about?' And we're able to demonstrate the notes are working a lot harder than they used to work, because the external environment's changed. And this kind of conversation and knowledge can now feed into all the conversations we have with our customers. This is unprecedented. So last century, in Russia, there was a three-rouble note, and the price of vodka in Russia was three roubles, and that was one of the most popular bank notes in Russia for a very long time, driven partly by that.

#### **SLIDE 54 - DLR Analytics examples - quantifying the impact of issues**

Here's another example. So notes will typically be issued by the central bank, and at that point they're put into circulation. They will get used, and eventually via different mechanisms, they'll come back to the central bank to be sorted. The central bank will typically sort the notes, and if the notes are fit for circulation – so if they're still looking new, if they're still at a quality level that is acceptable – they will then get pushed back out, so reissued. If the notes are below a quality threshold, the banks will declare those notes as being unfit, so within Analytics, we also track the rate that bank notes are declared unfit, and whether this changes with time.

So in this example, a central bank has changed its sorter, and it's changed the quality levels at which it decides a note is unfit or not. So they're happy, in the sense that through analytics, they can then start to quantify the savings they've got because of the changes that they've made, but there's also two spikes here, and they were instances where the sorter had malfunctioned, so it was destroying notes that it shouldn't have been destroying. And because they were tracking the information with analytics, they're able to see these spikes, and because the data's there, they're then able to quantify the cost of these spikes.

So the central bank can then start to say, 'We accept that things will go wrong with our sorter occasionally, and we accept that this is the cost', or they can make a conscious decision to say, 'This is costing us too much money'. It was about 500,000 notes that were being destroyed each spike in this instance, so they can say 'This is costing us too much money. We either need to employ someone to help maintain the sorters better, or we need to start a project to make sure this doesn't happen again.' So it's an example of how the data is there through analytics to help central banks make better decisions.

#### **SLIDE 55 - DLR Analytics examples - impact of central bank decisions on banknote lifetime**

Here's another example. So in this example, the central bank moved to a more durable specification, and they didn't see the benefits that they expected to see. But at the same time, they dropped the number of notes in circulation, and the notes had dropped to such a level that the note life was being impacted by the circulation volume. So by working with them, we could get the number of notes in circulation up, and consequently the note life increased, and it kind of makes sense intuitively. You can imagine, if you had 10 £10 notes in your wallet and you went to pay, there's a 10% chance of that note being used. If you only had one £10 note in your wallet, that note's going to be used for the transaction, and it was this kind of philosophy. These notes were working incredibly hard, because there weren't enough in circulation.

#### **SLIDE 56 - DLR Analytics examples - aggregated and anonymised data**

So as well as individual insights and knowledge about the cash cycle that we give to the central banks directly, we also take the data and we aggregate it, and we anonymise it behind the scenes. So here's a flavour. So this is showing you – it's a point of time. It's at the end of the



pilots we did, so in May. 15 central banks – and this is the average life of a paper bank note from analytics, and this is the average life of a polymer bank note. So you can see that the data is telling us that on average, polymer bank notes are lasting more than two and a half times longer than paper bank notes. If you're not used to looking at box plots, imagine that we lined up every single bank note from the one that lasted the least long to the one that lasted the most long. This line here is the middle point, when they're all ordered, and the blue box shows you 50% of the data, and any of the stars up here show you outliers.

But what starts to get interesting is there's some instances here where the polymer and the paper are having a similar note lifetime, and then we can get into 'Is it because you have a higher quality of fitness standards before you destroy the notes?' Down here, if somebody's going to maliciously destroy a note – cut it in half with a pair of scissors, or put it through a shredder – it doesn't matter whether it's polymer or paper. Up here, you have some paper bank notes that are used as storage of wealth, so we're able to advise central banks, 'If you've got a paper bank note, it's being used as a storage of wealth, you're happy with it, there's no issues. There's no need to move to a polymer bank note, because these notes aren't coming back to get sorted and destroyed, and they're being used as a storage of wealth.' So with all this information, we can help the central banks make conscious decisions about whether to move from paper to polymer, and we can advise in the most sensible way.

So I think there was a question before on competitors and what they're doing in this area, so perhaps it's useful if I touch on that before I finish. At the moment, we're in a blue ocean. So we have come in with something that is available to all central banks and that is accessible to all central banks. It's built on mathematical models we've taken a few years to develop – so we started this in 2012 – and we've got confidence in it, because we've also run studies with serial numbers and sorter analytics, and we know that the data that you're getting out of this is good. We've also run pilots with other central banks.

Where we are aware of activity is among central banks who tend to be the exceptions in our sector, who are investing in Big Data solutions themselves. There is some competitor activity, typically around sorter analytics. We're in a completely different position. DLR Analytics is an affordable and accessible solution that is available to all central banks around the world. And we've got a road map, so we are evolving the forecasting bit.

So I think that's it for analytics. I hope that's clear.