Traceability: 
towards a history of everything

By Adrian Henriques
Most people are curious about the history of things because they may care about where the pair of jeans they are interested in was made and by whom and under what sort of conditions.

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About this report

This report is about how much companies care about traceability and why – and what they actually do about it. It includes a series of case studies of what particular companies are doing about traceability. To do that usefully, it is helpful to be able to have a common framework for assessing traceability and how much of it there is within the lifecycle of a given product. A simple framework is sketched out at the beginning and pointers for its further development are set out towards the end.

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What’s the point of traceability?

Traceability raises difficult questions. Where does everything come from? And where does it go to afterwards? History and destiny. Cosmologists have given these questions a lot of thought – and actually have an answer to the first question. Everything came from the Big Bang. However there is some disagreement on the second question as to where everything will go.

Unfortunately, the cosmological approach does tend to leave out the sort of details that are of interest to ordinary humans, such as ‘what about me?’, ‘what about my car?’; ‘what about that pair of jeans in the shop?’. Most people tend to focus very much nearer home than the grand beginning of the universe some 13 billion years ago or its possible dreary end many hundreds of billions of years in the future.

Most people are interested in the history of things because they may care about where the pair of jeans they are interested in was made and by whom and under what sort of conditions. Was it slave labour? Or did the person who sewed them have a decent job? Or perhaps worse, were children employed to make it? Some people care about the origin of the food they eat: was it really grown in an organic farm? Was the pig that became my piece of bacon reared with concern for its welfare? Some may care where their phone was made because they worry about jobs being lost overseas.

Because consumers care about all these things, companies have started to do so too. When what was yesterday’s campaigning becomes today's tabloid headline screaming about the irresponsibility of one company or another, then consumer-facing companies realise they have to know the answer to ‘where does everything come from?’; at least as far as their own products are concerned.

Of course people are also starting to care more and more about where everything goes, too. This is largely through a concern about the environment or health. Plastic bags are a good example: people have seen how they can harm wildlife or ruin beaches and they don’t like it. According to the NGO Plastic Oceans, “We are now producing nearly 300 million tons of plastic every year, half of which is for single use. More than 8 million tons of plastic is dumped into our oceans every year”.

Companies have other reasons to care. As the pressure for consumer-facing companies to avoid social or environmental harms increases, they impose that need on their suppliers if they can. This means that business to business companies need to demonstrate the credentials of their products to their customers - if they can.

Companies may care about the destiny of their products too. McDonalds does not like to see its branded cups ending up as visible litter as it is likely to affect their brand.

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The business case for traceability

From a purely business perspective, in addition to public pressure, there are several sound commercial reasons for all businesses to be interested in traceability, at least to the level of understanding how much traceability they have in their supply chains. These reasons include being able to:

1. **Underpin quality.** In order to monitor and maintain quality, it is essential that the precise origins of components are known. Should quality problems emerge, the ability to track a given component back to its manufacturing supplier or on to its final use is essential to initiate recall or put in place corrective measures.

2. **Demonstrating value chain compliance.** There is strong and increasing regulatory pressure for supply chain transparency from the Dodd Frank Act in the USA and the Modern Slavery Act in the UK. In addition scandals in the retail food chain and those of other industries are demanding greater investment in traceability.

3. **Reassure consumers.** There is intense and growing interest in the workings of supply chains from consumers. This encompasses the ability to ensure adequate labour standards for agricultural workers, for example, or to deliver health and safety for food products.

4. **Underpin the security of supply.** As resources, such as rare earths or cocoa, become more scarce or subject to social or political volatility, the protection of supplies will become increasingly critical to business success. One aspect of the response will be to enable materials to be more fully traceable.

5. **Support corporate sustainability claims.** Those organisations that wish to improve their sustainability impacts, whether for commercial or ethical reasons, need to be able to track their products in order to do so effectively. Traceability is also important to support claims about the extent to which companies participate in the circular economy.
Overview of a traceability framework – the story of a duck

Despite all these reasons to care, it is surprising how little most companies know about the traceability of their products – or even about their supply chains. Sometimes even knowing who their suppliers really are is a challenge. If it is rarely possible to implement full traceability, is it possible as a first step to develop a framework to assess the level of traceability that currently exists? Such a framework could help control corporate risk and enable a fuller accounting for environmental and social impacts.

Since traceability systems almost by their nature require cooperation and communication across organisational boundaries, it would be natural to expect standards to have an essential role to play. Yet the overall picture of traceability standards is fragmented. Typically, different industries - and sometimes different products - each have their own traceability systems. Moreover organisations that have a measure of vertical integration in their operations may develop proprietary traceability systems. While this may be a valid response by the organisation concerned, it deepens the overall global fragmentation.

What could a traceability framework look like? Since traceability is relevant to all tangible products and is essential for accountability, it should apply to their entire lifecycle: from the origins of its components in the ground to their final disposition after use. On closer inspection, three aspects of traceability stand out when trying to assess the level of traceability:

- Scope
- Robustness
- Level.

Scope

Value chains typically extend from the land, sea or air and ultimately go back to the land, sea or air. Take a plastic toy: this may be manufactured from oil that has been pumped out of the ground in the USA. That oil will have been refined and processed, probably also in the USA. The oil will then be converted to ethylene, the feedstock for polyethylene, and finally converted to polyethylene plastic. The plastic may be purchased by a toy manufacturer, possibly in China. There the plastic can be melted, coloured and formed into yellow rubber ducks. The ducks will be packed up in boxes, the boxes loaded onto pallets and the pallets into containers. The containers will be transported by road to a dock - perhaps Guangzhou near Hong Kong. From Guangzhou the rubber ducks may be shipped to Southampton in the UK. The importer may stockpile the ducks in a warehouse before shipping a relatively small number of boxes to a tourist shop in Liverpool. There a tourist from South Africa may buy one of the ducks and eventually take it home to Cape Town in South Africa, where the duck may live for a few years enjoying a pampered life. One day our erstwhile tourist’s son insists on taking the duck to the beach at Muizenberg. The duck performs well on the choppy waves, being very difficult to sink. However a large wave comes in and the backwash carries the duck from the boy’s reach and out to sea.

The story from there is more difficult to trace, but could include being carried around the world on the ocean currents. The duck may end up on a beach in the Cook Islands in Polynesia. Or it may be eaten by an over-enthusiastic shark and carried in its belly for 25 years before sinking down to the depths of the sea bed, as it was punctured in the shark’s enthusiasm to eat it. Eventually, over possibly many thousands of years, the duck will be consumed and metabolised by microorganisms, but little is known of the long-term fate of plastics.

So what part of this long and complicated value chain is traceable? In principle all of it - but in practice, not very much at all. The difficulties include:

- Not knowing very much about the supply side of the value chain, particularly for commodity products such as polyethylene – and usually knowing less about the demand (ie the consumer or customer) side
- Not knowing how to identify the product. Before our plastic duck was a duck, ‘it’ was a part of a shipment of polyethylene and before that particles of oil possibly from different oil wells around the USA.

That means in practice that decisions will be made as to the boundaries that an organisation may even attempt to trace. But it is important that the entire value chain is understood at some level, otherwise there is nothing with which to compare the knowledge that an organisation may have about its value chain. So the ‘scope’ of traceability is the extent of a lifecycle which can actually be traced for specific products. Particularly when dealing with risk, it is the areas that are not known that usually present the biggest problem.

In order to assess the scope of the traceability of a product within a particular value chain we need to have a rough idea of the entire value chain (if not the whole lifecycle) so that we can compare the extent of what is known to be traceable with the whole value chain. From a practical point of view, one of the things that is most useful about this is appreciating the extent of what is not known. Yet it is perhaps from the unknown that most difficult risks arise.

Of course, the scope of traceability will vary depending on your point of view. The UK distributor of the plastic ducks will know about the traceability of the ducks up to the delivery to a retailer, but probably little else. On the other hand the manufacturer will have a very different view, probably also forward looking along the value chain as far as the UK importer, but again, little else.
Robustness

Assessing traceability has to relate the actual path or world-line of a given object to what we know about it. The IT and communications systems we develop to hold that information must therefore be taken into account in the assessment. The quality and reliability of those systems varies: in some we may have a lot of confidence and in others, very little.

For example, it is possible that the importer of the plastic ducks keeps records on a spreadsheet. Provided their business is not too large or too varied, that will probably work well. But their staff of perhaps 3 people, may not be especially well-trained or committed. Sometimes they will make mistakes, especially with data entry, and unless those mistakes affect the financial side of things quite directly, they are not very likely to get noticed. A spreadsheet is not a very reliable IT system.

On the other hand, the manufacturer of the ducks could have a quite sophisticated system for recording the despatch of the pallets with ducks in. The boxes could each have a bar code and the pallets themselves a related, but different one. Each box and pallet may be scanned on despatch and the pallets perhaps again at the port. On that part of their journey, the ducks’ adventures are well catered for.

Now suppose that there is a slightly different type of plastic duck that has been designed for the ethical billionaire. It still floats in the bath, but it has an interesting feature: it has diamond eyes. Moreover the diamonds are conflict-free and controlled by the Kimberley Process. Some of the main features of the process are that rough diamonds crossing borders should be within a tamper-resistant container and accompanied by a government-validated certificate. The idea is to ensure that only diamonds that do not fund conflicts can be sold and enter the world markets. We can suppose that the duck’s eyes are also ‘fingerprinted’. This can be done, for example by capturing how the facets of a cut diamond affect a laser beam shone on it.

In this case, because the items are of high value, more attention could be paid to its identification (the fingerprint system) and to the security of some parts of its journey through the Kimberley Process requirements. That will certainly enhance the robustness of the traceability systems based on it, but it does not merit complete confidence. The integrity of the Kimberley process depends on a lack of corruption in those issuing or checking certificates and the identity of a diamond could be altered by re-cutting it.

The robustness of traceability is a property of the information systems on which it depends. There are several techniques that may increase robustness. One is the use of blockchain technology to capture value chain transactions and events. Another is the assurance of the data held. Both are expensive.

There is also a persistent problem that can undermine traceability: the identification and marking of products. For the parts of the value chain to which they are applied, barcodes and other labelling mechanisms appear to support robust data. However, barcodes and labels are literally only as good as the glue with which they are attached. In this case ‘robustness’ has a very practical interpretation.

Level

The level of traceability is one of the intuitively easiest aspects of traceability to grasp, but maybe the hardest to measure. In the history of our plastic duck, we have noted the following key points in its journey or path through the world:

1. Oil extracted from the ground
2. Oil converted into polyethylene
3. The manufacturing process
4. Transportation to an exporter
5. Importation
6. Transfer to a distributor
7. Transfer to a retailer
8. Sale to a customer
9. Travel with the customer
10. Floating out to sea
11. Washing up on a beach.

That is eleven points, which may be more than are readily identifiable for most objects. However clearly the duck travels between them as well, so there is in principle an arbitrarily large number of points in there. The level of traceability is all about the granularity with which this path is known. At one extreme, full granularity could in theory be provided by real-time tracking. This is implemented for some distribution services that track where their various lorries are continuously in real time.

At the opposite extreme, but keeping to an aquatic theme, is some research done by the MSC into the origins of some of its certified fish. For biological organisms, DNA provides a way to identify a species of fish and given the location of a particular species it can be possible to be fairly confident that the same Hoki fish (a kind of hake) that can only have travelled from a location in the North Pacific to a dinner plate in London. That is impressive, but it is only two points. If that were all that were known about the fish, then the level of traceability would be low, compared to that provided by our fictional plastic duck. Of course the MSC is in practice very concerned with the chain of custody of its certified fish, so in fact a great deal more is known about MSC fish.

...there are several sound commercial reasons for all businesses to be interested in traceability...

What companies actually trace

The length and complexity of the global supply chains of the modern world may seem to make the task of achieving full traceability impossible. However a number of major industries already have significant traceability systems in place. The automotive, aircraft, agriculture, precious stones and some parts of the electronics sector are examples. The just-in-time techniques of car manufacturers, for example imply a high level of traceability. The catastrophic risks of aircraft engine failure mean that manufacturers know the position of their engines around the world in real time. And the many scandals connected with our food, mean that traceability in food chains can sometimes mean that a particular piece of tomato can be traced back to the row in the field in which it was grown. In addition, the bar code-based systems as defined by the GS1 standard provide the possibility for traceability for the parts of a value chain where they are used (but this information is not usually available to all actors in the supply chain).

However the majority of companies make do with very limited traceability, even for their core products. The following sections describe a series of projects within different companies that were driven by sustainability considerations to discover more about the traceability of their products. The main thing they all have in common is the current lack of traceability and the difficulty of improving that situation.

Supply Chain School

The Supply Chain School is a set of partnerships for those working in the construction industry within England, Wales and Scotland. This includes, construction, facilities management, homes and infrastructure sectors. It is dedicated to improving sustainability in the construction sector through working with supply chains. Topics addressed include waste, carbon, fairness and inclusion and modern slavery. The School is constituted as a set of partnerships. Its work is delivered by the organisation Action Sustainability.

In 2017 the School developed a protocol or method for supply chain mapping set out as a guidance document. This was designed to:

- Enable an organisation to understand who an organisation’s suppliers are beyond Tier 1
- Serve as a basis to reduce risk, eg relating to the Modern Slavery Act.

The guidance assumes that the organisation has the basics of supplier management in place. This includes supplier relationship management systems, sustainable procurement policies and supplier requirements on sustainability.

The protocol was based on identifying the supply chain actors for four products common in construction:

- A high visibility vest
- A floor cleaning product
- A black plastic waste bag
- Steel rebar.

The result for the high visibility vest is illustrated below.
A key contribution of the protocol is to provide advice on the approach to contacting supply chain actors and the information required. In practice, for the four products which were mapped by Action Sustainability, this was a laborious task. Suppliers were typically very suspicious of the project for commercial reasons. A particular fear was that the exercise would reveal that their company would appear to be ‘inefficient’ or to be adding little value to the procurement process overall.

The next step in the exercise for the Supply Chain School is to develop the mapping process at a category level, rather than that of a specific product. This would make the exercise of much wider applicability – though depending on how it was done, this could also reduce the level of individual item traceability.

Overall, the Supply Chain School approach shows the value to be gained from understanding more about an organisation’s supply chain. However it underlines how little organisations know about some of their common, more commodity-like, products. It also shows that without an even deeper knowledge of the supply chain, full product traceability is simply not possible.

A further stage mapped the country locations of the various supply chain actors against the Global Slavery Index assessments of the risk of slavery in the countries. This led to the map below.
Walgreens Boots Alliance (WBA) is the largest pharmacy and drugstore retailer in the world and one of the largest retailers of any kind in the world with about 385,000 staff and some 13,200 stores in 11 countries, including the USA, the UK and Thailand. It runs 390 distribution centres and delivers products to over 230,000 destinations, including pharmacies and hospitals.

WBA also sells a very wide range of products ranging from pharmacy items, cosmetics, food, gifts and home electrical products. With such a vast range of products, interest from customers and NGOs in where its products come from is very real. From labour conditions in its supply chains to the extent of the use of more sustainable wood products, the scope for things to ‘go wrong’ through events beyond its control is broad. In addition, regulatory trends are also moving towards more demanding regulation, especially in relation to transparency. The Modern Slavery Act in the UK and the Dodd Frank Act in the USA are examples.

So there is external pressure on WBA that could be addressed through a greater understanding of its many supply chains. There are also growing commercial interests that lead to the same conclusion. These include the growing complexity of its supply chains, compounded by growing resource scarcity for some key components together with growing price volatility. Moreover this fragility of supply chains comes at a time when global sustainability issues such as climate change can threaten the stability of supplies quite directly.

On the demand side of the value chain, consumer confidence needs to be maintained. However there is a risk from adulterated or fake products. Without a being able to trace products through to consumers, it is much harder to defend against such threats to brand image.

WBA businesses are actively working on traceability for a range of higher risk materials. This includes commodities connected to deforestation risks such as palm oil, and timber as well as other natural ingredients. However the company is working to develop a more comprehensive approach to traceability in its supply chain and has undertaken three pilot initiatives to that end. One is the collaboration with the Retail Palm Oil Transparency Coalition, the second, the Beauty and Personal Care Coalition, a collaborative initiative with other retailers in the USA to address sustainability in their supply chains. The third is a pilot mapping of traceability for selected products.

For WBA, palm oil and palm kernel oil are key feedstocks for a number of ingredients in a wide range of products, including cosmetics. The nature of the palm oil supply chain is interesting as it is typical of a range of commodity products. Its overall shape is that of an hourglass:

- There are large number of palm oil growers, including both small family businesses together with some very large plantation owners
- Raw palm needs to be processed and refined. There are a relatively small number of refiners. At this stage the oil derived from different suppliers will be mixed together, making full traceability very difficult
- There are an even smaller number of traders and importers of palm oil, each handling very large volumes. Again, oil from numerous suppliers may be further mixed together at this point
- Palm oil is made into other substances and incorporated into products. There are a relatively larger number of such manufacturers
- The manufacturers from which retailers actually buy (their Tier 1 suppliers) are more numerous still
- Finally the retailers themselves – although there are a small number of major retailers, like WBA, there are a very large number of retailers overall, many of them being small businesses.

The Retail Palm Oil Transparency Coalition is a group of retailers that want to have a greater understanding and influence on the palm oil supply chain than can be achieved through simply buying certified materials. This goes further than the issues currently covered by the Roundtable on Sustainable Palm Oil standard. A key goal is to be able to hold palm oil importers to account over their deforestation commitments. In order to do that, it is necessary to engage with importers, who are in effect the guardians of traceability back to plantation level, and to be able to trace palm oil back to its primary source.

The aim of the Beauty and Personal Care Coalition is to consolidate the criteria used in the industry to vet their suppliers. The motivation is to ensure that the way suppliers are selected promotes sustainability and increases market incentives for more sustainable products. It would also reduce the costs associated with supplier surveys for all parties concerned. From a traceability perspective, to have commonly accepted ways of analysing supplier information should be helpful in achieving greater transparency.

The third initiative attempted to address the topic of traceability directly. For a small number of owned brand products, the goal was to map complete traceability for all the materials in the products and their packaging by using information that was already available internally. One of the key goals was to understand the gaps and potential risks arising from the knowledge of traceability that WBA actually has.

The analysis started from the list of ingredients of these products, including the packaging. The list is long, the following being quite typical:

- Aqua
- Glycerin
- Prunus amygdalus dulcis (Sweet Almond Oil)
- Caprylic / capric triglyceride
- Butylene Glycol
- Mica

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3 As of 31 August 2017, using publicly available information for AmerisourceBergen.
Despite the length of this list, it is probably not quite complete as the label will have been stuck on with glue and printed with ink. The outer packaging may likewise be printed. Nevertheless, this does illustrate the challenge that full traceability entails. Moreover two of the ingredients listed above are derived from palm oil - caprylic/capric triglyceride and cetearyl alcohol – given the challenges of understanding the palm oil supply chain, this underlines the depth of the problem that traceability presents.

Starting with the supply side, it was found that internal systems held data on the origin of most of the ingredients. Notable exceptions included palm oil-derived ingredients and parfum, which is a proprietary perfume formulation. However for some ingredients the location or name of the organisation concerned was not known. In addition it was not always known which organisation was responsible for the various steps in the chain, whoever actually undertook them.

There were a number of practical observations also:

- While a good deal of information on the supply chains was available, it was typically held across several different systems within WBA, making it difficult to locate.
- Most of the information was derived from first party declarations – that is the various companies within the supply chain provided the information, but it had not been possible to checked or verify.

One of the surprises was that more information was available for the supply side than for the demand side. Once products were dispatched towards customers, less was known about the routes that it took. This was partly due to responsiveness to the rapidly changing demands of the business. If an opportunity to supply a new market opened up, for example, then products on route to one destination might be diverted to the new market. There was also a counterpart to this on the supply side in that many ingredients are sourced from multiple suppliers, so the routes taken could vary from batch to batch.

If a consumer pays by cash for the product, then all traceability is lost from that point on. Of course the product itself will ultimately be washed down the drain or taken to landfill.

In the light of the complexity presented by the products studied, and considering the large number of products handled by WBA, it was felt that full traceability would not be feasible to implement. An approach would be developed that was based on risk. The result will be that high-risk products would be subjected to greater scrutiny than lower risk products. The criteria for risk would include the likelihood of either environmental, social or commercial damage.

The work that WBA did was mainly concerned with a detailed mapping of the supply (and demand) chain. What then, is the difference between traceability and a detailed knowledge of the supply chain?

A supply chain is a series of commercial relationships between the set of organisations that together deliver the product to the purchasing organisation – and by extension on to the consumer. If you want to be able to track the path that a single instance of a product took, then knowing the supply chain is a pre-requisite, but it does not exhaust all that ‘full traceability’ would provide. As we have seen, it does not necessarily even include the location of the organisation – or even of the organisation’s facility that handled the goods.

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## Siemens Rail Automation

Siemens Rail Automation is part of the large Siemens group. It provides the signalling, monitoring and operational control systems for trains and mass transit systems. Increasing demands on public transport mean that the optimum use of rail lines is one of the central problems of modern railways. Siemens Rail Automation provides control and signalling systems to meet that need. Cables are central to Siemens Rail Automation projects.

- Conductor or core: made of copper or aluminium (either copper solid or stranded)
- Insulation: ensures that conductors and other metal substances do not come into contact with each other, typically made of PVC of cross linked polyethylene
- Bedding: used to provide a protective boundary between inner and outer layers of the cable, typically made of PVC
- Armour or braid cable: provides mechanical protection, which means the cable can withstand higher stresses, be buried directly and used in external or underground projects, made of tinned copper or aluminium
- Outer sheath or jacket: low smoke zero halogen fibre made of polyethylene (PE) or polyvinyl chloride (PVC)
Power cables generally consist of conductors, insulation and a protective sheath or jacket. Signalling cables used for Network Rail can be purchased from a variety of manufacturers or distributors that supply cable to the appropriate specifications. Cables to this specification are manufactured with 650v insulation between cores and 1100v between any core and earth. The key components of such cabling are:

- PVC
- Polyethylene
- Copper
- Steel
- Glass
- Aluminium
- Tin.

Siemens has published a ‘Code of Conduct for Siemens Suppliers’ which addresses legal compliance, prohibition of corruption and bribery, respect for basic human rights of employees, prohibition of child labour, health and safety of employees, environmental protection and supply chain. All Siemens suppliers sign up to the code and are expected to comply with its requirements.

Thameslink

The Thameslink Programme is a major upgrade project run by Network Rail, the state-owned company responsible for the UK’s railway infrastructure. The Thameslink Programme is intended to upgrade a key north-south rail line that runs through central London. It includes delivering new, longer trains, upgraded stations with longer platforms – including a complete re-design of London Bridge station – and laying new track and signalling. Siemens was asked to deliver the new signalling components for Phase II of the project. That required the purchase and installation of 928km of cables, both for power and signalling – by far the largest item by value of those procured, amongst the many hundreds that were purchased.

Network Rail has a Responsible Sourcing Policy in place. This does not call for the immediate elimination of problematic products and materials in the supply chain. However it does promote a risk-based approach to the selection and design of new products and materials, throughout the lifecycle of the item.

Siemens initially developed a ‘heatmap’ approach to dealing with the sustainability risk that their role in the project presented. This involved an attempt to visualise the sustainability risks associated with the project and display them on a map. The level of risk was defined as the product of the impact of occurrence and the likelihood of occurrence. It was soon recognised that the number of components involved in the Siemens part of the Thameslink project was too high to enable a complete analysis – it would be too complicated. Therefore the risk analysis focused on cables alone as the most significant single element of supply.

The criteria for the risk analysis were:

- Responsible sourcing – interpreted to mean compliance with a recognised good practice sourcing scheme
- Environmental health impacts
- Durability and maintainability.
- Extent of recycled/reused content
- Local sourcing
- Workplace health and safety
- Country of origin, where EU-compliant sourcing would be an indicator of low risk
- Country of origin, where non-EU sources are graded by recognised labour or political issues. Poor reputation could be mitigated by participation in schemes such as Fair Trade
- Consistency with Network Rail environmental policies, eg in terms of energy consumption
- Supplier responsible sourcing policies in place

However it was felt that the number of components needed by Siemens for Thameslink would effectively mean that a large effort would be expended on materials and components that would not present a significant risk. Also, the heat map criteria were not felt to reflect the total risk, including commercial, that a particular product might represent. Therefore effort was re-focused on a case study approach, where the most significant products, based on commercial exposure would be followed up in detail.

The process that was followed was to first interview Siemens’ three Tier 1 cable suppliers. Of these, two were unable, at the time of the analysis, to trace their projects to source. However, one of these two suppliers were planning to implement a database that would have been able to record such information.

The third supplier did manage to trace much of their product back to source. This particular supplier used five manufacturers, of which one did not respond to requests for information, while the others declared a number of countries in Europe, Asia, South America, and Africa as the source of the various components of their cable. Two manufacturers were selected for further investigation, which made it possible to trace the aluminium, tin and copper back to a specific mine.

Rail construction project

For a second major project, the client conducted an audit of Siemens and agreed that Siemens should undertake a ‘deep dive’ with two of their key cable suppliers, with the following objectives:

- To determine the ethical sourcing risk of a key material used on the project
- To build a profile of the material’s supply chain by mapping suppliers, which in turn would provide a better understanding of the supply chain beyond Tier 1
- To determine availability of the data and existing methods of capturing it (if applicable)
- To evaluate engagement with the issue of ethical sourcing within the supply chain.
Cable suppliers were chosen for the study because of the material’s cost, the large quantity purchased and its critical function for the project. Risk was assessed through mapping of the countries where suppliers were based against a series of criteria derived from the ETI base code. These were all human rights and labour risks – there were no environmental criteria. The known risks within each supplier country enabled a picture to be built of which risks were dominant for each of the two studied supply chains. It was found that forced labour was the biggest risk in the cable supply chains – to the extent that they were successfully mapped.

It fairly quickly emerged during the study that it was going to be very difficult to complete the mapping. Although the supply chain down to Tier 4 and 5 was discovered in some areas, it did not prove possible to take the process any further in the time available. In particular it was not possible to discover the ultimate source of the copper conductors at the heart of the cable that Siemens supplied.

The main problem in undertaking the mapping was that suppliers were very wary of providing information about their own suppliers and sometimes even about the nature of the product they were supplying. Their fear was that the information would be used commercially against them. Assurances were given that the information was for the purposes of supply chain ‘visibility’, not purchasing decisions and that no information would be made public.

In practice this meant that some suppliers simply did not respond to initial enquiries or refused to participate. While some of the Tier 2 suppliers undertook to contact the next tier for information, in other cases the supplier merely provided organisation names, but did not arrange an introduction. This made the initial contact by Siemens difficult. The further down the supply chain the study went, the harder it proved to locate the right person within the supplier organisation, and to discover the information needed.

The countries in which suppliers were based included:

- Russia
- Poland
- Finland
- Sweden
- UK
- Germany
- Austria
- Norway
- China
- Japan
- Spain
- Ireland
- France.

The main conclusion was that the further down the supply chain the study went, the less information was obtainable and the greater the risk of human rights and labour impacts became. In addition, in order to successfully undertake supply chain mapping, education, trust and collaboration would be essential. And on a wider, industry level, the risks in supply chains need to be managed collectively.

For both of these major projects, a decision was made to focus on cable. This makes sense in terms of the value and volume of the product in relation to the overall contracts Siemens Rail Automation held. However it also means that there is a risk that smaller value components, or those purchased in smaller quantities were overlooked – even where they might carry a high sustainability risk of some sort.

The chief finding from Siemens’ work in this area is the practical difficulty of discovering information about supply chains. Even with willing Tier 1 suppliers, it was not always possible fully to discover the full supply chain involved. Yet it also emerged that many suppliers were not that willing, and sometimes extremely reluctant, to share what they regarded as commercially sensitive information. This attitude was maintained even when it was pointed out that the large global company Siemens was the high volume end-purchaser of the suppliers’ products.

Finally, in each case, the objective was merely to discover the commercial relationships that eventually delivered the products to Siemens Rail Automation. While this is a crucial piece of the traceability puzzle, it is far from the whole of it. In order to trace a product it is essential to know which organisations are trading it to each other to form a supply chain. But that is a number of steps removed from being able to follow a particular piece of the product as it travels through that supply chain – and of course it stopped with the client, not at the end of the product life.

**Technical traceability**

**Dimensions of traceability**

So far we have glossed over the type of information that traceability systems cover – or rather treated them as if they were all similar. But the journey of the plastic duck encompasses a number of ‘dimensions’ of interest.

The journey of the plastic duck can be seen as a ‘value chain’, that is a representation of the series of owners of the duck in question: oil manufacturer, duck manufacturer, importer, etc. But when we initially traced out the rubber duck value chain above, we were also interested in its location. Indeed for global supply chains, the journey through geographical space is often the most impressive part. But there are also other kinds of actors in the process. One of these is those who may not own the duck, but whose role is to look after it for others. The exporter of the duck from China may be in this position: they will not own the duck but are paid to keep it in a warehouse for a while. Finally the material of the duck goes through a series of transformations. First the ‘duck’ was a lot of oil particles; these were then changed into plastic; the plastic was then moulded into a duck.

Understanding a supply chain is a far cry from having traceability. Supply chains are mainly defined by the set of organisations that work and trade together to deliver something to an organisation – as we have seen in the case studies presented above. Knowing from which organisation something is bought is clearly a part of traceability, but knowing my supplier is not the same as knowing when a particular instance of a product was bought from that organisation, where it travelled and when it was finally delivered.
Moreover, the phrase ‘supply chain’ is sometimes used to cover only supplies delivered to an organisation, but not what happens after it is sold on. The term ‘value chain’ can be used, but is again not entirely appropriate since many steps in the life cycle of an item may appear to have little to do with value.

Lifecycles are complex. To have full traceability means to know where something is at any stage of its lifecycle. But it is more than knowing simply where it is, or who owns it. The full set of information that may be needed at each point in a lifecycle includes at least:

- **Location.** This includes not only places where something may be stored, but also, in the limit, real time information about its movements between places of storage or use.

- **Ownership.** The identity of the organisation that owns something is an independent variable from location. Of course in some cases, when something is delivered its ownership changes – but it is entirely possible that the owner of something, perhaps a bulk commodity like wheat, changes while the wheat in question remains in the same warehouse.

- **Guardianship.** Independently of ownership, another organisation may be appointed to look after a product. This may happen if the items are valuable or likely to be smuggled or adulterated in some way to circumvent regulation or standards.

- **Transformation.** In a typical value chain, raw materials are combined with others. An essential oil may be dissolved in a carrier oil, for example. Unless this is captured, traceability of the item will be lost.

- **Application.** The item may also be used for its intended purpose. In the manufacture of electronic components, for example, solvents are used to remove grease from circuit boards.

From a traceability perspective, all of these dimensions can be of interest. They form logically distinct paths in the world. And of course, the same company may fulfil different functions – safeguarding the duck while also owning it is perfectly possible, for example. The reverse is also true in that several companies may deliver the same function, perhaps at different times, but also simultaneously. So the path a duck traces in the ‘ownership space’ is an important part of its traceability, but only part of it.

The full traceability of something can only be provided if the ‘position’ of the item is known in each of these dimensions for all points in its lifecycle. That is a tall order and does not even remotely occur for most items. But for some it does – for radioactive products, for example, a significant amount of the information is known. But where there is no risk or other reason to do so, it rarely happens.

There is one important refinement to the information requirements for traceability. That is the credibility of the information. While it may be thought that a certain product was shipped at a particular date from a particular location, who says so?

Typically such information is reported by the party it concerns. Provided there is no motive for the reporting organisation to alter the data, that may be good enough. Nevertheless, where there is a lot of money at stake, the information may be verified by another organisation. Shipments of bulk commodities, for example, are checked on arrival to ensure that they are indeed of the type and quality required and that there has been no unwanted transformation during the voyage, such as spoilage. So from an information or database perspective, the full traceability records for an item will need to have a credibility value also – for each and every entry of the five variables listed above.

**Traceability and Chain of Custody**

Traceability can formally be defined as the ‘ability to trace the history, application or location of a product’. It is about with the ability to discover the path (i.e., history, application or location) which a particular item actually follows. The practical ability to capture the path an item takes will require a traceability system to record the events as they take place. A traceability system will capture all the events on the paths travelled by a product across the various dimensions of traceability.

A chain of custody is a chain of responsibility for the guardianship over materials as they move through a supply chain. Its purpose is to ensure that the specific characteristics that are claimed for a particular instance of a product are indeed the ones that are actually delivered.

Different chain of custody models achieve this in different ways supporting different claims about the material. While the implementation of a given chain of custody model will imply a particular level of traceability, the function of a chain of custody system in general is to avoid having to trace specific products to support the claims being made, because the security and integrity of the chain of custody procedures for product handling make it unnecessary.

**Conclusion**

Industries which deal with very high value products, such as diamonds, or where the business risk or risk to the public is very high, such as food manufacturing, have reasonable traceability systems in place. Yet in practice, few products or their components can be traced fully to their source – or to their final disposition after use. This lack of traceability exposes businesses of all kinds, from primary producers through to retailers, not only to reputational damage, but also to compliance and financial risks. Currently there is no feasible, credible and widely accepted framework for assessing the degree of traceability of products throughout a value chain.

In addition, without knowing where the parts of a product come from - and where they go after manufacture and use - it is not possible to put in place fully robust processes to determine what their impacts may be. And without that, in addition to the increase in commercial risk, corporate strategies for responding appropriately to environmental and social impact become haphazard.

Until far better traceability is the norm, there is a need for a framework to assess the degree of traceability that actually exists in a given value chain. That is itself a challenging task.