



Inter Material



Labelling to ensure appropriate handling
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A Step Beyond Wrapping Products

不只是包裝這麼簡單

Text by Steve Jarvis Photographs courtesy of Evigence Sensors

For all its ubiquity and diversity, product packaging doesn't get the attention it deserves. What attention it does get is usually negative, and for good reason, as plastic packaging is choking the world's waterways and wreaking havoc on delicate ecosystems. However, there are important developments underway in the world of packaging, and we talk to industry thought leader Dr. Claire Sand to discover what is on the horizon for the humble product package.

產品包裝現今無處不在，亦非常多元化，但似乎沒有人留意到它的重要。人們對包裝的看法，往往都是比較負面的，原因包括塑膠包裝會阻塞水道，對脆弱的生態系統又會造成嚴重的破壞。然而，在包裝領域裡正發生重要的改變，我們訪問了業界的專家 Claire Sand 博士，探索這看來豪不起眼的產品包裝的前景。



Temperature and time sensitive labels will change inventory management and bring savings to consumers
對溫度和時間敏感的標籤，將改變庫存管理，並為消費者節省金錢。

Even after three decades in the industry, academic and consultant Dr. Claire Sand is clearly excited about the future of packaging. "Materials is a really fun area to be in right now, precisely because there is so much going on. In terms of the value chain, supply chain problems caused by numerous crises and the COVID-19 pandemic are forcing companies to adopt contingency materials to cater for shortfalls and supply problems. These external stimuli are helping the industry to change and speeding up the adoption of higher performance packaging."

Sand points to a one-third increase in polymer prices in 2021, "Which prompted companies to save money on production costs by increasing filler material, such as starch, enabling them to reduce the amount of polymers needed to make PET bottles. I think economics is driving the increased use of alternative and sustainable technologies very rapidly." However, economic incentives have limits, and Sand does not shy away from the problems packaging is creating, something especially obvious in food packaging.

"Nearly one-third of all food produced ends up in the waste system. What makes it worse, the vast majority of it is thrown away at the end of the supply chain after all the value-processing, packaging, and distribution has been added." She is also quick to note that reducing this waste and increasing the amount of recycled and recyclable packaging is difficult precisely because the food system is set up to produce 30% more food than is being consumed. Sand elaborates on the dynamics behind this situation:

"If you are a farmer, and you find out you will lose 30% of your income, you are not going to be happy about that. Brands have done a great job in reducing waste in the production side of the equation because it directly comes out of their bottom line. But when it comes to reducing wastage in the hands of the consumer, incentives are just not as strong because they directly affect the production value chain. Although, recent food price increases should encourage consumers to make the switch to packaging that is proven to extend the shelf life of the food."

"Given this economic disincentive within the food system, it will take a cultural change in society to increase recycling rates. We need people to expect better packaging, and demand fewer points of friction when they try to recycle," said Sand. "However, the packaging industry also needs to step up to make packaging more sustainable, more effective at its job, and

easier to recycle. There needs to be a systems-level change to make this happen, and the industry needs to be better at doing its job of protecting and tracking the products we use."

Smart packaging is active and intelligent

Enter "smart packaging", an amalgam of technologies that together promise to create packaging that better caters to the needs of consumers while also reducing its negative effect on the environment. Active and intelligent packaging are two forms of smart packaging.

Active packaging employs technology that intentionally releases into or absorbs compounds from the food or the headspace of food packaging. These actions extend the shelf life of products by stalling the degradative reactions of lipid oxidation, microbial growth, and moisture loss. "As active packaging becomes more mainstream, even more innovation and application will become possible as the technology is increasingly refined to protect brand integrity and extend food shelf life. Active packaging technology is on the cusp of enabling personalisation of food just before eating, and increasing manufacturing agility. Also, we are starting to see packaging that deliver nutrients, flavours, odours, textures, and colours in response to environmental conditions, time, or consumer interaction."

"On the other hand, intelligent packaging communicates to consumers and others throughout the value chain, from food manufacturers, distributors, retailers, consumers, to post-consumer package handlers. Freshness indicators are used in some intelligent packages to communicate the shelf life of products within the value chain – for example from blueberry farms to grocery distribution centres. However, because so much food waste occurs after the purchase of food products, it is essential to ensure that freshness indicators can also communicate to consumers. The use of freshness indicators that indicate shelf life after opening and current freshness can be expanded to decrease food waste and increase the value of packaging."

"It is now possible to do so much with packaging, including all the active and intelligent options, but the next level could be to also use packaging as a communications device to the consumer to tell them how to recycle the package, and how they could possibly benefit from doing this correctly. It is possible to even track all aspects of the recycling and make it into a competition amongst friends and neighbours to improve the recycling rates."

Sand is optimistic that technology will soon push communicative packaging to the next level. "We have been able to print RFID tags, etc. for a long time, but the real game-changer in this area is being able to print packaging that includes a thin-film battery, essentially they are printing a battery on paper. This research is now advancing rapidly and is attracting a lot of interest within the packaging industry."



The label changes in response to time and temperature change
標籤會隨著時間和溫度改變而變化

The future is integrated packaging

For Sand, integration is the most exciting thing happening in packaging right now. "We are really good at active packaging, and have been using it for a long time and there are lots of great innovations. With intelligent packaging, we are communicating things like temperature, what temperatures a product has been exposed to, and how this is related to potential dangers from microbes. Linking the two together presents tremendous opportunities for the future."

This integration of packaging is starting to be referred to as the Internet of Packaging (IoP). "It holds incredible opportunities, primary of which is a fully integrated value chain. When we have this, not only can we record specifics such as location and harvesting details, but also the nutritional breakdown of the contents of that individual container. Moreover, it is all trackable and traceable. I believe the potential for IoP is profound because it connects all this data to help create a more sustainable packaging system for the entire value chain."

While much of the technology is already here, Sand notes "It is the actual adoption of more sustainable materials, technologies, and especially consumer action that need to be better addressed." She goes further to identify the largest stumbling block, "The number one thing is waste collection. It may sound strange, but it is true. There are amazing technologies and material science out there, great recycling facilities, and RFID technologies incorporated into the packaging, but it is for nought if we don't collect it. If recyclable material can't be collected, the value chain breaks down."

Designing for recycling is key

"We need to make consumers responsible for what they buy, not just the product, but also the packaging, and this responsibility is not being effectively communicated. One of the big trends we need to understand is "recycle ready", designing packaging to make it incredibly obvious to consumers how a package can be pulled apart and made ready for recycling. Brands are finally doing this, but the ultimate responsibility lies with the consumer, which is a fundamental area requiring action." She continues, "Collecting waste isn't sexy, but it is so important, and we need creativity in solving these problems."

Sand has a suggestion for designers, "It is critical that packaging designers are designing for recycling right from the very start. To do this successfully, it needs to be made so obvious to the consumer what action to take. In addition, it needs to be done for different types of consumers and economic brackets, and it requires consumer testing to work out what is really intuitive." She notes that health and beauty aids provide good examples of adaptation, and these once complicated high-end packaging products are now much easier to break down. Sadly, most other products have a long way to catch up.

Well aware of their role as an interface between producer and consumer, Sand issues a challenge to designers, "We need to design products that will encourage consumers to recycle. This is an emotional challenge, which can only succeed if we better connect with people's desire to help the environment. I think this is a truly worthy design challenge for our age."

即使已在業界工作了30年，身為學者和顧問的Claire Sand博士仍然對包裝行業的未來充滿憧憬。「正因為周圍有這麼多事情發生，物料領域變得非常有趣。在價值鏈上，由許多危機和新冠肺炎疫情引起的供應鏈問題，正迫使企業採用應急物料來應付短缺和供應相關的問題。這些外來的刺激正幫助業界改變，加速他們使用更高性能的包裝。」

Sand指出，2021年聚合物價格上漲了三分之一：「這促使企業通過增加使用如澱粉等填充物料來節省生產成本，從而令他們減少用於製造塑膠瓶的聚合物量。我認為經濟上的考慮因素正迅速推動替代性物料和可持續技術。」然而，經濟誘因是有其限制的。Sand並不回避包裝所帶來的問題，這一點在食品包裝方面尤為明顯。

「在所有生產的食物中，有近三分之一最終會被浪費。更糟糕的是，在經過加工、包裝和分銷的流程之後，絕大部分在供應鏈的最後一段就被丟棄了。」她還指出，減少這種浪費或是增加可回收和可循環使用包裝的數量都很困難，因為食物系統的生產量比消費量多出30%。Sand詳細闡述了這種情況背後的原因：

「如果你是一個農民，而你發現你將失去30%的收入，你是不會感到高興的。品牌在減少生產環節的浪費方面做得很好，因為這對會直接影響他們的利潤。但是當涉及到減少消費者層面上的浪費時，動機就沒有那麼強烈了，畢竟這直接影響到生產價值鏈。近期的食品價格上漲應該會令消費者轉買那些確實可以延長食品保質期的包裝。」

「鑑於在食物系統裡不利的經濟因素，要提升回收率，社會必須在文化上作出轉變。人們要期待更好的包裝，而且要減少他們在回收過程中遇到的阻礙。」Sand說。「然而，包裝行業也需要更加努力，使包裝更具可持續性，並且更容易回收。這個目標需要在系統層面作出改變才能實現，更要好好保護和追蹤我們所使用的產品。」

智能包裝——活性包裝和智慧型包裝

「智能包裝」這個技術，一方面創造出更能滿足消費者需求的包裝，同時亦減少對環境的負面影響。智能包裝的形式包括活性包裝和智慧包裝兩種。

活性包裝藉著釋放或吸收食品與食品包裝空隙的化合物的技術，從而延遲脂質氧化、微生物生長和水分流失的降解反應，延長產品的保質期。「隨著活性包裝成為主流，保護品牌誠信和延長食品保質期方面的技術日益完善，更加創新和更多的應用便可得到發展。活性包裝技術在推動餐前食品個性化和靈敏生產模式極為重要。此外，我們開始看到根據不同環境因素、時間或消費者互動而發出不同的營養、味道、氣味、質地和顏色的包裝陸續出現。」

「另一方面，智慧包裝不單與消費者互動，還對整個價值鏈中的其他人從食物生產商、分銷商、零售商、消費者，到消費之後的包裝處理人員聯繫。有些智慧包裝使用了新鮮度指標，傳達價值鏈，如從藍莓農場到雜貨店分銷點的過程中產品的保質期。然而，由於食品被購買後會出現大量浪費，因此讓消費者了解新鮮度指標也是很重要的。多利用能夠表示開封後及即時的新鮮度指標，可以減少浪費食物，亦能增加包裝的價值。」

「現在包裝能夠做到的，包括活性包裝和智慧包裝的事情有很多，下一步是包裝或許可作為一種與消費者溝通的媒介，告訴他們如何進行包裝回收，和讓他們知道正確回收對消費者本身又有什麼好處。我們甚至還能追蹤回收的每一個環節，將這成為朋友和鄰居之間的賽，以提高回收率。」

Sand相信科技很快會便會將互動性包裝推向一個新的水平。「我們能夠打印RFID之類的標籤已經有一段時間了。但是真正的變革，是能夠打印含薄膜電池的包裝，本質上是在紙上打印電池。這項研究正在快速進行中，並在包裝業界引起了高度的關注。」

整合包裝是未來的方向

對Sand來說，整合包裝就是當下令人興奮的趨勢。「我們在活性包裝上已經做得很好了，也做了很長時間，許多包裝也是非常創新的。智慧包裝可讓我們傳達不同信息，例如溫度、產品所處的溫度，以及怎樣的溫度會造成怎樣的微生物風險。將活性包裝和智慧包裝兩者結合起來，能為未來造就許多機會。」

整合包裝開始有包裝互聯網 (IoP) 這樣一個稱號。「這蘊含極好的機會，首先就是它可以完全整合價值鏈。當我們有了這個技術，不僅可以記錄地點和農作物收穫的細節信息，還能了解單一容器內的食物營養細節，而且這一切都可追蹤和追溯。我相信IoP的巨大潛力，因為它可以把這些數據連接起來，為整個價值鏈創建一個可持續的包裝系統。」

雖然大部分技術現已存在，但Sand表示：「我們仍要採用更多可持續物料和技術，其中，消費者的行為便要著墨更多。」她進一步指出最大的阻礙：「第一是廢物收集。這聽起來可能很奇怪，但事實確是如此。儘管有先進的技術和物料科學、良好的回收設施和融合在包裝裏的RFID技術，但若我們沒有把廢物收集起來，這些作用都等同於零。如果不能收集可回收物料，那麼價值鏈就會斷裂。」

回收設計是關鍵

「我們需要讓消費者為自己的購物行為負責，不僅是他們所購買的產品，還有產品的包裝，這個責任仍未很有效地向消費者傳達。我們需要理解的一個大趨勢是『回收就緒』，即包裝設計能夠非常明確地讓消費者理解包裝應如何分拆以準備回收。品牌終於開始在做這點，但最終責任依然在消費者身上，這是需要實際行動的基本環節。」Sand繼續說道：「收集廢物不是什麼有吸引力的事，但是卻非常重要，我們需要一些創意去解決這些問題。」

Sand對設計師有一個建議。「包裝設計師應該從一開始設計就考慮到回收問題，這一點至關重要。想要成功做到這點，便需要向消費者清楚表明如要他們回收，需要採取怎樣的行動。除此之外，還要考慮到不同類型的消費者和經濟類別，以及進行消費者測試，看看他們怎樣才會以最直接的反應去正確回收。」她指出保健和美容產品就是很好的例子，這些產品過往曾使用繁複又高端的包裝，現在更則容易拆解了。然而，其他產品想要趕上，仍有很長一段路要走。

Sand深知包裝設計師作為生產商和消費者之間的連接角色，因此向設計師提出挑戰：「我們需要設計出能鼓勵消費者回收的產品。這是一項有感染力的挑戰，只有我們可更好地與人們希望保護環境的願望聯繫起來，才能成功。我認為這個設計挑戰在這個時代是非常值得做的。」



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