Digital Industrial Policy Brief 7

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REPOSITIONING THE FUTURE OF THE SOUTH AFRICAN CLOTHING AND TEXTILE INDUSTRIES

Robert Stewart[1]

Introduction

The terms digitalisation, "Industry 4.0" or "factory of the future" are used interchangeably to broadly describe the increasing potential to integrate the parts of the manufacturing value chain with the aid of digitalisation. There are multiple ways to approach this topic and this briefing document describes these disruptions in relation to the Clothing and Textile (C&T) industries through five interconnected themes: increasing data availability through object linked sensors; object interconnectivity providing large data sets and associated powerful business analytics; the application of artificial intelligence to big data to enable machine learning and responsiveness; new materials availability and capability; and finally the increasing use of additive technologies and robotics capable of working either autonomously or with human collaborators. As these technologies converge, additional and rapid advancements become possible as knowledge and capability accelerates exponentially, shifting manufacturing and associated business processes from isolated silos to a single integrated system across the globe.

While transforming products and the methods of reaching the market, digital technologies are also driving changes in consumer behaviour. Consumers are increasingly seeking apparel and fashion products that support their individual preferences and biomechanics through competitively-priced customisation. This demand for individuality is further propelled by greater consumer access to information and a desire to prescribe what they buy, be it in the idea or design stages, materials used or manufacturing practices that are expected to meet their personal interpretation of sustainability. This growing fragmentation in demand - personalisation and customisation - can already be seen in trends towards smaller batch runs in production as C&T retailers reduce their reliance on long-term forecasting and associated purchasing models and turn towards higher levels of mass customisation and the introduction of rapid response systems to reduce inventory redundancies and fashion irrelevance. The rapid advancement of digital disruptors on a global scale will accelerate this trend[2]. So what are these disruptors?

[1] B&M Analyst. www.bmanalysts.com

[2] Mostafiz Uddin. Interview published in Dhaka Tribune on November 22, 2017.

Internet of Things (IoT)

IoT refers to the rapid expansion and reduction in the cost of embedding technology in traditionally non-smart objects, enabling connectivity and consequent communication between those objects and already smart objects (such as smartphones). Estimates range significantly as to the number of current smart devices, online cable devices and potentially trackable objects. Similar variances are evident in respect of estimating their growth trajectories and future valuations. Gartner analysts predict that by 2020, the IoT will include nearly 26 billion devices, adding $1.9 trillion in global economic value[3], whereas the IDC forecasts the existence of more than 30 billion smart devices by 2020, comprising a $3 trillion market[4]. It is approximated that the opportunity for value creation is equally split between marketing and sales, and supply chain advancements.

The Industrial specific application of IoT is often referred to as the Industrial Internet of things (IIoT). For manufacturers the most basic level of IIOT is that embedded sensors allow for objects to be located in both time and space, an application useful for product and asset management. When mapped digitally this location capability enables the foundation of a digital or virtual factory to be created, ultimately enabling a factory "avatar" or twin that can be remodelled, manipulated and adapted to simulate proposed changes and the implications thereof without touching the physical factory.

At an even more advanced level, connectivity by and to objects enables degrees of remote control within an entire value chain connecting multiple factories – for example sending new designs to a weaving loom that automatically alters its own pre-programmed settings accordingly, or a smart phone app that instructs sewing machines to adjust their settings according to new product requirements[5]. Remote control capability also enables better utilisation of utilities through a "smart grid" - such as energy use monitoring, phased equipment start-up or shutdowns and individual machine water use statistics. Most of these capabilities already exist and are used in one form or another in more modern manufacturing plants where integrated PC boards allow remote monitoring and management of individual machines and plant-level base statistical monitoring.

As managers of supply chains and input materials, live visibility for retailers, design houses and manufacturers as to the location of inventories helps to improve decision-making and responsiveness to problems as they arise, such as materials shortages, missed deadlines, quality failures and production waste. Barcode scanners and RFID tags are examples of this technology already in use. Some of the challenges faced by clothing manufacturers specifically relate primarily to the relative cost of retrofitting sensors onto machinery and the closed software platform architecture being favoured by some of the larger machine suppliers that limits integration across older capital equipment and different brands, as well as within the broader C&T value chain.

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[3] Gartner (2016). Returns – The New Battle Ground for Retail. Available online: http://www.metapack.com/wp-content/uploads/2015/02/Returns-The-new-battleground-for-retail.pdf.

[4] IDC (2014). The Internet of Things: Data from embedded systems will account for 10% of the digital universe by 2020. Available online: http://www.emc.com/leadership/digital-universe/2014iview/internetof-things.htm.

[5] Personal experience with TFG Manufacturing Division.

For the retail market, the physical location and status of products in time and space enables greater real time visibility into the location of inventory as well as product performance at various points in the value chain. This data, if handled correctly, enables more accurate matching of demand with supply. Point-of-sales systems are examples of this functionality and are necessary to establish the basis of a more advanced analytics capability. As the costs of the sensors fall and their form changes (perhaps woven into fabrics) so they become more viable in lower cost value fashion segments of the market.

At a more advanced level, body scanning sensors enable garment fit customisation in ways that traditional internet ordering and off-the-shelf purchases cannot accomplish. Combined with computer-aided-design, this enables the rapid construction of customised apparel. For instance, Alton Lane, a high-end menswear is one of a growing number of companies using body scanners to improve the accuracy of the first fit and claims to have reduced their costs as a result, enabling them to improve service and achieve customisation[6]. The US military have invested in this technology to better match body sizes and shapes to battle fatigues and equipment, while sports brands routinely use this for their brand ambassadors. While the technology is not yet suitable for less niche markets, the high return rates of garments bought online, estimated between 10% and 40%[7], highlights the potential value of unlocking this technology for the broader market as well as the need to improve the returns pipeline amongst digital strategies[8].

With consumer demand increasingly focusing on sustainability – whether in the form of reduced chemicals use, biodegradable packaging, ethical manufacturing or other credence value parameters - including information about products is becoming increasingly important for information hungry consumers. Such data can also assist with mitigating counterfeiting in that consumers can potentially scan codes and access information about product authenticity. Missing shipments can also be tracked by the legitimate owners of merchandise, or criminal investigating authorities.

One of the potentially significant impacts of embedded technology and the availability of information about products is the change in the traditional role of the retailer, who has typically controlled access to consumer information through its brick and mortar channel. Design houses with appropriate technology can potentially directly access market performance data relating to their product and either empower themselves and their customer through direct data analytics or bypass the traditional retail role by selling their product on one of several online platforms. As such technologies enhance the link between product performance data and information about consumer preferences, they start to challenge the traditional role and power dynamics of players within the C&T value chain, especially when combined with new means of distributing products.

While sensors, connectivity and data acquisition are imperative for IIoT, the primary purpose of the technology is much greater than data collection. The capability forms the foundation

[6] https://www.fastcompany.com/3035092/heres-what-its-like-to-step-into-a-3d-body-scanner-for-a-custom-made-suit

[7] https://www.cnbc.com/2016/12/16/a-260-billion-ticking-time-bomb-the-costly-business-of-retail-returns.html

[8] See footnote 3 above.

and path to something much larger and more powerful, namely "big data" and eventually through to Artificial Intelligence, machine learning and fully automated responsiveness and production.

Big Data

By continuously collecting and storing large quantities of data, statistical evaluation of very large and representative data sets is enabled, provided appropriate analytical methods are applied to the data sets. Advanced analytics on big data supports the manufacturing practices of predictive maintenance, failure-mode-effects-analysis (FMEA), health and safety management and overall plant optimisation through computer driven data analysis at speeds far faster than human capability.

Interconnected machinery also enables "smart grids"- real-time energy monitoring and optimisation at a plant or even multi-plant level. Wide-scale analysis of plant performance allows managers to optimise their problem-solving resources and reduce the costs of lost production time through initiatives targeting enhanced labour utilisation and safety, as well as machine, materials and production methods[9]. Traditional methods of problem solving requires long periods of often manual data collection and associated logic processes that are subject to human bias, whereas big data analytics using appropriate algorithms are far faster and subject to less bias (if programmed correctly). Big data also allows for advanced statistical analysis that scrutinises relationships and causality across typically unconsidered groups of variables – for example the ambient temperature in one part of a factory against material performance in another part of the production process[10], or enabling the creation of digital factory twins[11]. These issues are not new in and of themselves as they represent the heart of lean business methods and applications; however, by unleashing the power of big data the speed and outcomes of process and product improvements are significantly advanced.

These advancements require cyber-physical systems to allow humans to interact with the data and more importantly, convert the raw data into useful, actionable information. In its simplest form this could be represented by a dashboard of metrics for the user to monitor and act upon. However, as technology advances the cyber physical engagement incorporates AI that can respond to situations autonomously. In a robotic form this can relate to the repairing of machinery, or to the supply of parts and materials to production lines alongside, or independently of workers[12].

From a marketing and sales perspective, gathering and processing data on product performance (e.g. sold versus unsold) is only one-dimension of the opportunity. Big data

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[9] Hagel, J., Brown, J., Kulasooriya, D., Giffi, C. and Chen, M. (2015). The future of manufacturing. Making things in a changing world. Deloitte University press. From the Deloitte Center for the Edge. A report in the Future of the Business Landscape Series.

[10] Personal Experience. Hugo Boss Izmir Turkey, 2017.

[11] The Economist (2017a). For robots to work with people, they must understand people. https://www.economist.com/science-and-technology/2017/08/17/for-robots-to-work-with-people-they-must-understand-people.

[12] The Economist (2017b). Adidas's high-tech factory brings production back to Germany/ Making trainers with robots and 3D printers. Available online: https://www.economist.com/news/business/21714394-making-trainers-…and-3d-printers-adidass-high-tech-factory-brings-production-back.

permits the interrogation of the consumer experience around the product itself (for example, why tried on in a change room, but not purchased; or purchased but only worn once?). As such the product itself becomes a platform around which information streams can be created and from which other services or products may be developed and offered to the consumer. This creates the opportunity for retailers to shift from being providers of a physical product that is then owned by a consumer, to being providers of product platforms and associated services that support their lifestyle choices based on the information gathered from them.

A practical example of this application is Zara's in-store hand held devices that enable sales personnel to capture information about the product and consumer behaviour towards the product. This data is transmitted to a data centre in La Coruna, Spain, and analysed for trends and patterns which in turn are interpreted into new products, and a set of supply chain metrics to determine where and when the products would best be manufactured. Their large "nerve centre" in La Coruna displays real time data and information on a range of metrics that enable rapid response times to emerging problems, trends and opportunities, many of which are automated. Downstairs from the nerve centre, the prototyping of products is supported by digital mirrors that digitally switch the colours and prints onto the models' mirror image, enabling designers to see the look and fit of an item without making them in multiples. The plan to launch this into stores would transfer this same benefit to the consumer while also creating data on consumer preferences such as correlated fitting with purchases. This insight into garments that are visually attractive but not purchased can signal a fabric feel or fit problem for example that can then be addressed. When all this data is combined with that from point-of-sales terminals and transmitted to its design and logistics teams, Zara's "accurate fashion" model is enabled, and the guesswork associated with predicting consumption patterns is removed. Applied globally, the scale and routinisation of its distribution networks increasingly enable Zara to send specific products to specific locations, thereby matching location-specific consumer preferences and demands – the definition of mass customisation[13].

When body scanning technology is combined with rapid production methods such as automated knitting, digital fabric printing, additive manufacturing and automated embroidery, mass customisation starts to move into the realm of mass personalisation, signalling a fundamental shift in the supply chain processes required to deliver products to consumers.

Before discussing production technology advancements and its implications, additional digital disruption impacts in the market place are worth considering. While the automotive industry is seeing start-ups that allow customers to participate in the entire design to manufacturing process (e.g. Local Motors), apparel and accessory businesses are focussed primarily on securing consumer participation in the ideation and associated design creation process, with this being done through crowd-sourced input from mobile social media streams. This reduces the risk of launching all-new product designs and better aligns end-product design and production volumes with target market preferences and likely demand (as experimented with by *Threadless*[14]*)*. Some brands have even secured upfront payment from customers on new product launches. Crowd-sourced input also supports product and process innovation and

[13] KZN CTC and CCTC Zara study tour report. 2016

[14]Brabham, D.C. (2010). Moving the crowd at Threadless: motivations for participation in a crowdsourcing application.

reduces reliance on a team of in-house experts while securing greater levels of brand buy-in across selected markets. As consumer markets continue to fragment, engagement with consumers will become more relevant – and widespread, as enabled by the lowering costs of digitalisation.

The implications of digital disruption and continued market fragmentation are multi-fold, raising numerous challenges and questions: Traditional consumer categorisation and generalisations are breaking down into less easily measured and quantified sub-groups requiring designers and retailers to engage more directly; the advantage of retailers in controlling access to and the flow of information about consumers through physical stores is diminishing and new platforms are emerging that provide far more powerful means of engaging and reaching consumers; as traditional value creation methods break down and new ones arise, who creates value and who captures that value? Who owns the customer relationship", and what parts of the traditional value chain become less important or even redundant? As markets and demand fragmentation accelerates, how will traditional mass manufacturers of a narrow range of products remain relevant and keep pace with the demands for smaller but ever more frequent batches of unique products? And finally, with the acceleration of data availability and automated analytical capabilities able to understand constantly evolving market developments, how will established businesses within the C&T value chain respond?

At least this last question has the beginnings of an answer: Artificial Intelligence.

Artificial Intelligence and Machine learning

Artificial Intelligence (AI) represents the new frontier of analytical capability and responsiveness. The sheer volume and rate at which analysis needs to be converted into decisions and implemented are increasingly beyond the capability of human capacity alone. The need for rapid learning and autonomous responses based on repeat experiences embedded in vast volumes of data requires a far greater level of hardware and software, processing power and networking capability than currently installed at most businesses. It therefore has, at least currently, significant cost implications. Unsurprisingly, current adoption rates amongst C&T manufacturers is extremely low suggesting that mass market apparel design and manufacturing will be late AI adopters: probably only once off-the-shelf applications are readily available. Some leading brands, such as Hugo Boss, are experimenting with big data and AI applications and while the potential benefits of AI are conceptually understood, and these initial experiments are suggestive of AI's potential, the short product life-cycle nature of the fashion market make AI applications particularly challenging. Similarly, the challenges identified in the clothing sector relating to sensors on equipment are proving to be difficult to overcome outside of some niche areas, while the lack of off-the-shelf applications keep the cost of AI high and above the means of volume driven low margin businesses.

It is therefore unlikely that the lower end of the market (CMT businesses as an example) will be able to ever take on the AI challenge independently; i.e. outside of a lead value chain actor or industrial cluster. The responsibility and opportunity therefore lies primarily in the segments of the value chain that operate at sufficient-scale and generate sufficient financial margin to consider how and where to apply AI.

Some of the larger international retailers such as Inditex Group have for many years been applying advanced technologies to pursue their first-to-market, accurate fashion objectives. By deploying modern technology to keep pace with consumers' on-demand lifestyles and combining short production and distribution lead time to offer highly desirable products the company has established itself as the international retail benchmark. Their application of, for example, in-store to headquarter communication systems, fashion attribute-based algorithms that adjust design, product and production allocation depending on demand, have been built on big data platforms and imply a continual focus on AI applications. The rapid growth of omni-channel retailing and specifically on-line sales platforms has in the last decade accelerated the availability of consumer behaviour data and methods to shape that behaviour. As the stream of information about consumer interactions with products grows, so the need for AI is accelerating to make sense of the data flows. The rapid growth of online apparel growth is indicative of the power of providing fragmented consumer groups with access to products supporting their lifestyle choices, while simultaneously providing the retailers with greater amounts of data on their consumers to better meet their emergent needs. Retail has not been deaf to this challenge. H&M recently announced the intention to apply AI to improve trading decisions along with a multitude of other traditional "brick-and-mortar" retailers moving into the omni-channel space[15].

However herein lies one of the greatest challenges, how does a traditional retailer and its associated supply chain, with embedded ways of working, skills, systems and infrastructure move into AI and retrofit its technologies when the disruptor has the potential to fundamentally alter the way the entire value chain works? Inditex grew up building this form of culture and capability from the start and so applications such as AI, while challenging, really represents an evolution to them. For other retailers (and their often-long-established vendor bases), it is indeed a revolution with implications all the way back into their foundational systems. This challenge represents the real threat as new entrants such as Amazon and many other digital start-ups are wired for disruption. These entrants would appear to have a massive advantage precisely because they are not encumbered by legacy supply chain systems, technologies and skills-sets.

Nano-technology, smart materials and green-technology

Nano-technology applications in fabrics and apparel have been in place for several years already. Anti-microbial fabrics for dressings and hospital sheeting are commonplace in developed countries, while wrinkle-free fabrics are already mainstream in fashion fabrications. "Stitchless" or seamless technology, where a special glue responds to sonic waves to fuse layers of fabric together, is already being used in South Africa to produce fashionable water and windproof outdoor wear. Reports claim that seamless methods reduce production time by 25% to 35% less than cut-and-sew methods and reduce labour input.

But now rapid advancements in chemistry and biology, fuelled by big data and AI, are fundamentally changing both the nature and use of fabrics and apparel. Scientists are increasingly able to direct nano-particles to assemble and then behave in a predetermined

[15] The Wall Street Journal (2018). H&M Pivots to Big Data to Spot Next Big Fast-Fashion Trends. Available online: https://www.wsj.com/articles/h-m-pivots-to-big-data-to-spot-next-big-fast-fashion-trends-1525694400.

manner to perform specific functions, with extensive applications in the medical field such as rapid wound healing bandages and tourniquets; and outdoor gear through sunblock infused sports and swimwear and stain and odour resistant fabrics. The growing ability to incorporate dynamic materials, such as conductive fibres, solar panels and self-healing properties into the fabric creation stage is also advancing the functionality of certain types of made-for purpose apparel, such as military-wear, reducing the need for external wiring, antennas and heavy battery packs while improving safety.[16] Personal and professional sports science is benefitting from inserted thermochromic inks into sports apparel and the introduction of apparel-integrated wearables to create smart materials such as *Adidas' sensor apparel*[17].

The focus on the water usage, carbon footprint and emissions impact of the C&T industries are leading the larger textile and apparel brands to implement more environment-friendly manufacturing techniques to reduce their impact and simultaneously differentiate themselves in the marketplace. For example, Nike's Flyknit running shoes are made with 60% less waste than the typical Nike production methods[18]. In 2010, Levi's developed the industry's first "waterless" jeans called Water<Less that involves a set of manufacturing processes that claims to reduce up to 96% of the water normally used in production[19].

There is also an increased focus on making commercially applicable dyestuff from bacteria; yarns and fabrics from plant materials; and fabrics and materials from organic and inorganic waste. Current production methods are not yet at a mass commercial scale, but the convergence with digital technologies and links between nanocellulose technologies and additive printing (for example) may lead to capabilities suited to mass customisation.

An emerging market disruption that may offer an alternative to conventional retailing is that of rented and recycled apparel. Apparel renting businesses, such as Rent the Runway and Beijing start-up YCloset, are explicitly targeting the fast fashion daily wear market[20]. At a combined 20 million "members" (not necessarily trading) the businesses use their digital platforms like those used by the leading fast fashion retailers themselves to track popular styles and product durability and to reach the market, these rental companies claim substantial and growing membership (if not actual customers). Business models renting apparel are now also being blended with companies that offer a buy-back or rent option for recycled products. An example is *Mudjeans*, a European company that sells and rents denim jeans made of mostly organic and recycled denim that are then returned and shredded into small pieces, blended with new organic cotton and turned into to a new pair of jeans[21]. Start-ups of this

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[16] Advanced manufacturing (2014). An uncommon thread. Conductive fibres: From lighter aircraft to electric knickers, flexible filaments raise a wide range of interesting possibilities. Available online: https://www.economist.com/news/technology-quarterly/21598328-c…flexible-filaments?zid=293&ah=e50f636873b42369614615ba3c16df4a

[17] The Economist (2017c). Gemini makers. Millions of things will soon have digital twins From factories to cars to a range of consumer products. Available online: https://www.economist.com/news/business/21725033-factories-cars-range-consumer-products-millions-things-will-soon-have-digital.

[18] Nike (2018). https://news.nike.com/news/sustainable-innovation. Last accessed October 2018

[19] Levi Strauss (2018). www.levistrauss.com/sustainability/planet/. Last accessed October 2018.

[20] BBC (2018). Will we soon be renting rather than buying our clothes? Lucy Hooker for BBC News. Available online: www.bbc.com/news/business-45630395 September 2018

[21] https://mudjeans.eu/. Last accessed October 2018

nature remain niche and represent a very small fraction of the current market (0.1% of all apparel is recycled back into textile fabrics)[22] but growing interest in the consumer base, social media campaigns talking to the harmful impact of apparel industries and unusual combinations of consumer demand, business models and technologies are shaping the discourse and practices around how the value chain might evolve in the future.

While the examples provided above are in non-price sensitive, highly socially conscious market segments, the acceleration of digitisation and chemistry science, combined with growing sustainability pressures, suggest these market segments will become increasingly mainstream over time.

Additive manufacturing and robotics

Advances in additive manufacturing are arguably the digital disruptor with the most potential to upset the C&T value chain - by excising entire processes, machinery, distribution infrastructure and labour. Advances in 3D fit software combined with rapidly advancing additive manufacturing technologies, such as Carbon's Digital Light Synthesis™ technology currently in use by Adidas, will have a significant impact on not only product development but all functional areas of the value chain from design to prototyping and ultimately volume production. It is currently possible to go directly from computer aided design of a shoe, to the sharing of that design in 3D to anywhere in the world (with a decent internet connection) to the printing of a shoe last on an additive printer for the upper to be prototyped, with the sole being instantly printed also on an additive printer, without the need for the laborious time consuming transfers of fabrics and physical samples around the world, or a single human hand touching the last.

With the rapid acceleration in additive manufacturing technologies (Moore's law is now said to apply to the rate of progress being achieved), the economics of additive manufacturing is rapidly changing the costs of production and subsequently reconfiguring the business case for how value chains are organised. Additive manufacturing has the potential to reduce development times, the reliance on rare artisanal skills and materials usage. Being fully digitised, additive manufacturing can also reduce the time and logistics to transfer physical prototypes around the world. When combined with 3D design and fit technologies it removes the need to physically prototype product iterations or repeat orders. Significantly, the tooling costs and time to retool for prototyping is also eliminated. At some point, the speed and cost of additive manufacturing will make the technology usable at scale, and possibly at a cost lower than conventional mass production systems that have resulted in the present global organisation of C&T production. Adidas' new highly automated, flexible, additive manufacturing-based fast factories in the United States and Germany are early examples of the potential shift in the future global profile of C&T production. These plants can manufacture bespoke Adidas products within very short lead times for discerning customers in the United States and European markets and represent the first major shift in footwear production back into these large markets.

Combinations of digital technologies currently make it possible for initial idea sketches to be taken through the entire design and development process without any physical item being

[22] Salfino, C. (2017). The Apparel Industry is Ramping Up Its Apparel Recycling Efforts. Available online: https://sourcingjournal.com/topics/lifestyle-monitor/apparel-recycling-efforts-74381/.

made. CAD designs can then be transferred directly to robotic knitters for production. Mainstream technologies include automated fabric laying, automated nesting to maximise fabric cut yields, and automated robotic cutting. While sewing is still largely undertaken by human machinists, a fully automated robotic T-shirt assembly line using “sewbots” developed by Softwear Automation Inc. is set to for delivery in late 2019[23].

Despite the promises the technology holds, additive manufacturing technologies have yet to make a significant mark on fabric and apparel production and current levels of robotic automation in manufacturing have been limited to mostly fabric handling and cutting areas. The handling dexterity and shape-recognition skills of sewing machinists have remained beyond the reach of robots and will not be replaced at scale anytime soon. Even once robotics advance significantly, it is more likely that robotic co-workers (“cobots”) will be used to complement human workers, working on the most routine tasks.

Where robotics has made an impact on the C&T value chain is where online sales trigger supply chain responses via highly automated warehousing and distribution infrastructure. Pick-and-pack automation in distribution centers has accelerated dramatically, substantially reducing the need for semi-skilled labour in these functions.

While the impact of additive manufacturing and robotics on the C&T industries is arguably limited to date, the convergence and combinations of advanced robotics, new materials, new chemistry, and the changing dynamics of production economics will undoubtedly fundamentally change the nature of the global clothing and textile value chains in the future.

Where are we now?

Depending on one’s point of view of where and how digital disruptors will evolve, the ramifications for production and markets could either be dire or extremely attractive. If one takes the (very) extreme view that in the future an individual could scan their body, use AI to design a product and then additively manufacture it from the comfort of their IoT-enabled apartment, then the role and future of retailers and factories is seemingly one of obsolescence. A more moderate and likely scenario is that adaptation to some new form of retail and production relationship is not only viable but potentially very attractive for those firms within the value chain that can make the transition.

The South African Retail environment generally exhibits strong traits of being a follower from a digital technology perspective. While examples of progress in, and the use of advanced digital technologies, are evident (particularly in logistics and distribution centres), overall adoption rates and levels of sophistication are arguably low, with genuine supply chain integration at scale remaining elusive. Online sales platforms and digital streams focusing on customers remain limited, although growth rates of on-line product sales for some retailers are positive. The Mr Price Group reported an average 28% year-on-year worth in the first four months of its 2019 financial year[24], while online retailer Spree CEO claimed sales had grown

[23] Softwear Automation Inc. http://softwearautomation.com/

[24] Mr Price (2018). Trading Update. Available online: https://www.mrpricegroup.com/MrPriceGroupCorporate/media/mrpgcorp/SiteAssets/2018/Trading-update-August-2018.pdf.

88% year on year in 2017[25]. However total contribution to retail trade is very low at about 1% of total sales[26]. As such data collection outside of financial and some product performance variables is therefore largely limited. Product and consumer behaviour analytics based on big data is arguably far behind leading platforms.

These deficiencies are among several factors that expose both South African retailers and their supply chain vendors to major risks of displacement, particularly in an environment where the regulatory and production environment does not easily lend itself towards supporting localisation strategies. Domestic production facilities, unsurprisingly, exhibit very similar characteristics. As such the South African retail C&T value chain appear ripe for digital disruption. This would place the entire value chain at significant risk given the domestic manufacturers' embeddedness with domestic retail chains, making it unlikely that they will independently move into a new phase of rapid innovation without their value chain partner.

Progress and adoption rates amongst non-retail production facilities appear to diverge significantly depending on the dynamics of the value chain in which they are located (military, safety, government procurement etc.). For those firms positioned within advanced, export niches, there is evidence of change. The primary risk for these firms lies in their isolation from an interconnected, collaborative, data rich eco-system with the learning and feedback loops needed to lay the groundwork for new and more powerful digitally-enabled business models.

Despite these challenges, leaders in both the retail and production segments of the C&T value chain remain well-placed to capture the benefits of digital disruption. Whilst retailers have not advanced their capabilities particularly aggressively to date, they have other competitive advantages such as extensive credit books and loyalty card systems that "lock" consumers to them and provide a base off which to develop consumer-centric "big data" intelligence systems. Several retail-led clusters exist because of government funding and support, and these potentially lay the basis for deeper value chain partnerships central to effective digital disruption.

What does the future hold?

One of the key questions faced the South African C&T value chain is how rapidly the digital disruptions covered in this briefing note will affect the South African market. South Africa's C&T retail value chain has over 210,000 employees (with 120,000 in retail and 90,000 in manufacturing[27]) and contributes an estimated R74 billion of Gross Value Added annually to the national economy. Ignoring digitalisation threats and opportunities is therefore not an option.

[25] Fin 24 (2018). Exponential Growth Curve Ahead for Online Retail in South Africa. Available online: https://www.fin24.com/Companies/Retail/exponential-growth-curve-ahead-for-online-retail-in-sa-ceo-20180409.

[26] UNIDO (2017). National Report on E-Commerce Development in South Africa. Inclusive and Sustainable Industrial Development Working Paper Series. WP 18 | 2017. Available online: https://www.unido.org/api/opentext/documents/download/9922241/unido-file-9922241.

[27] A further 55,000 South Africans are employed in the non-retailing manufacturing portion of the C&T value chain. This relates to production for corporate wear, government contracts, and industrial and technical markets.

Given that the primary impact of digital disruption is likely to be less about whether South African consumers will continue to consume products (either rented or bought), and more about who (and how) products will be designed, made and ultimately sold to them, the risk appears to be one of either keeping (and advancing) domestic value chain capabilities or losing capacity and capability over time as South African retailers and manufacturers are displaced from the market by more competitive international retailing and production models The flipside of this dramatic scenario is that any South African retailer or manufacturer that successfully implements an effective digitisation strategy has the opportunity to expand globally. Thus, intelligent adoption of digital technologies may well be one of the central mechanisms to revitalising C&T production in partnership with the market facing players in the value chain.

Navigating the disruptions is, of course, extremely difficult as the trajectory as to how and when these technologies will converge and evolve is impossible to predict with any real accuracy. What is clear is that the convergence and re-combinations of these digital technologies will fundamentally change the nature of the clothing and textile value chain at some point in the future and the failure to adapt will likely lead to dramatic failure. The general nature of the private sector in South Africa, especially the under-pressure productive sector, is that in the absence of a suitable policy and regulatory framework, it will likely iterate forward based on short-term pressures, rather than embracing longer-term coherent and integrated digital business strategies. This incremental approach is fraught with danger, and likely to result in diminishing competitiveness. The associated impact on the retail sector will be equally negative as South African retailers become increasingly dependent on international vendors.

So, the need to develop a national policy response is clear, even if its specific content is less evident.

Some initial responses

The transversal nature of the digital revolution indicates that while stakeholders need to interpret developments for their own specific value chains and sectors; and regulatory mechanisms and programmatic content will need to be customised accordingly, the national broader policy environment and higher order regulatory systems should be agnostic of these dynamics. Transversally, South Africa should be looking to build the foundational infrastructure, institutions, skills and innovation strategies that enable proactive digital change irrespective of individual value chain dynamics. This review suggests that a suitable framework to approach this complex issue requires three interconnected dimensions to be considered.

First is that of rapid industrial policy adaptability - Following Dani Rodrik's framework for an effective 21st century industrial policy, South African industrial policies will need to be constantly reviewed and reoriented in alignment with the development and associated combination and recombination of disruptions[28]. This implies an institutional capability to rapidly iterate digital policy and implement recommendations based on proactive learnings and evidence-based experiences within value chains.

[28] Rodrik, D. (2004). Industrial Policy for the Twenty-First Century, Paper prepared for UNIDO, September 2004.

Second, successful digitisation requires a national system of innovation that adopts the adage of "thinking globally and acting locally". The fluid nature of digital disruptions and the unclear manner in which they will combine and then recombine requires that transversal skills and technology capabilities are developed and deployed, and then then finessed according to specific needs, again within appropriate learning loops.

The third dimension again draws on Rodrik: *"The right model for industrial policy is… strategic collaboration between the private sector and the government with the aim of uncovering where the most significant obstacles to restructuring lie and what type of interventions are most likely to remove them. Correspondingly, the analysis of industrial policy needs to focus not on the policy outcomes—which are inherently unknowable ex ante—but on getting the policy process right."* The South African C&T value chain's position globally makes it both extremely vulnerable to digital disruption and paradoxically well positioned to take advantage of emerging opportunities. If South Africa is to gain from the combining and recombining of digital disruptions, collaboration between the private sector, government, organised labour and research institutions will be central to determining a successful long-term outcome.

While the future profile of the global C&T industry is unclear, this brief review of digital disruptions raises some clear medium-term lessons for the SA C&T industry that can be used to start responding to emerging opportunities and threats, while simultaneously laying the foundations for future proactive digital adaptation. Four lessons are presented below.

1. First movers in the retail space have already secured an advantage by developing powerful, intelligent online aggregation platforms that enable them to engage the consumers' attention and customise their experience using Big Data and AI, and then rapidly meet that demand through highly automated and digitalised global distribution networks. If South African retailers and producers are to remain relevant, they will need to establish their own digital platforms for connecting with one-another and the consumer.

2. C&T value adding processes are likely to fundamentally change as new materials, additive manufacturing, nano-technologies, machine learning, AI, robotics and the application of IoT within value chains change the economics of production and consumption. Many of the digital disruptions cut across all manufacturing sectors and need to be supported at that level, but their specific combinations within the C&T industry also need to be understood and responded to at a specific value chain level.

3. Sustainability pressures within the C&T value chain will continue to grow in terms of environmental impact, ethical trade and localisation pressures. Disruptive technologies will enable the close monitoring of, and adherence to these standards, potentially fundamentally changing the economics of production and the nature of Global Value Chains. Production locations unable to verify their sustainability credentials may be increasingly locked out of leading global markets.

4. C&T value chain digitalisation pressures require appropriate institutions to research, engage, interpret and frame the national policy implications of emerging developments (using solid Monitoring and Evaluation methodologies and Big Data). Given the long-term and sometimes (at least initially) esoteric nature of such engagements and the

understandably short-term view of private sector investment horizons, incentives and funding from the public purse will be required to enable digital progression within the value chain.

The potential regulatory mechanisms that either transcend specific value chains and sectors or are specific to them are too numerous to list and beyond the purview of this brief, but will undoubtedly cut across legal, standards and financial authorities. Perhaps worth noting however is the potentially very positive impact digital technologies could have on regulatory implementation, particularly many of those seemingly intractable institutional failures typically debated in C&T public policy and regulatory reviews (such as non-enforcement of public procurement legislation, under-invoicing and illegal activities amongst others).

Once the institutional frameworks and associated policy and regulatory implications are established, programmatic content should naturally follow. There are several international examples that could be considered such as the US Federal Support Programme that includes partnerships with the National Additive Manufacturing Innovation Centre and University collaborations with open technology spaces, maker-fares and maker-gyms. All these initiatives drive technical capability, training and education and encourage technology start-up communes and networks. While C&T sector specific programmatic content will inevitably evolve over time, some shorter-term considerations could include:

1. Re-shaping existing and future incentive programmes to more explicitly and seamlessly reward innovation and R&D (without being overly prescriptive and bureaucratic), especially those that function through established public-private partnerships.

2. Mandate that incentive-accessing companies participate in Big Data approaches to Monitoring and Evaluation systems with a participation-qualifying requirement to be the establishment of appropriate business measurement systems within a prescribed period.

3. The more aggressive adoption of appropriate automated systems to monitor designated procurement thereby enabling this as a tool to encourage technology innovation partnerships and investment.

4. Consideration of carefully selected partnerships with leading digital institutions to support digital incubation through the dissemination and application of digital capabilities for the SA C&T value chain.

It is these types of C&T specific developments and associated responses that require a GVC-specific response on the part of national government and local industry stakeholders. The South African industry is no different to any other small economy globally: it is both vulnerable and potentially well positioned in relation to digital disruptions. Whether the industry wanes or prospers is dependent on the actions taken by stakeholders over the forthcoming period.