



RESEARCH IMPACT EVALUATION

Textor

July 2017

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1 Executive Summary

The Challenge

Australian manufacturing constantly faces pressure from increasing production costs and mounting global competition. To increase market share our manufacturing businesses need to grow through competitive advantage, and improved profitability. Entering and expanding into international markets is vital for the longevity of Australia's manufacturing industry. It is important that Small and Medium Enterprises (SMEs) receive the research and development resources and capabilities which allow them to maintain competitiveness in the global market.

Textor Technologies, a Victorian family-owned company, produces an array of technical textiles used in health care, personal hygiene and industrial products. These technical textiles that make up incontinence products in particular, focus on moisture management through permeable barrier materials. The competitive technical advantage in this product sector, comes from material with advanced fluid absorption. Textor's goal was to enter the international market by demonstrating a significant technical advantage over competitive products, many of which are produced in low labour cost countries.

Our response

CSIRO and Textor co-invested, initially through the then Commonwealth Department of Industry, Innovation and Science and "Researcher in Business" Program, and later via sequential bilateral arrangements, to conduct research into: surface treatments of textiles using plasma; understanding moisture transport via capillary action; odour reduction; and new composite web structures. Ultimately, the research culminated in the invention of a novel three-dimensional fabric that is employed as a next-to-skin component of predominantly infant diapers. The fabric, produced via hydroentanglement, is highly effective in facilitating moisture movement away from the 'point of insult' and into the absorbent layer of the diaper whilst maintaining a sense of dryness, and hence comfort, to the wearer. The product can be efficiently produced in large quantities.

The new material has been incorporated into the millions of nappies produced in Australia, the United States and Russia by global company Kimberly-Clark.

In addition to the pivotal and significant technical expertise of Dr Niall Finn, CSIRO also provided access to world-class research facilities that were customised to suit the project as an integral part of the research relationship, accelerating product development and therefore innovation.

The Impact

Through the Commonwealth Government "Researcher in Business" program, CSIRO was able to place a materials scientist directly into the business to work in collaboration with Textor.

CSIRO's commercial engagement with Textor resulted in a new product development, in turn increasing annual gross turnover. Textor now manufactures the novel moisture-management fabric, making it a key supplier to the global market via Kimberly Clark Corporation.

Textor has also invested substantially in its manufacturing plant, particularly in the areas of automation and data management to support expansion into international export markets, including the Asia-Pacific Region, Russia and the United States. Much of this investment occurred during the period of Australian/US dollar parity, taking advantage of currency strength to make capital purchases.

The export achievements and success of Textor, in conjunction with its ability to tap into the benefits of co-investing with CSIRO to achieve measureable outcomes, is a compelling demonstration of the ability of adaptable and determined Australian manufacturing companies to succeed in competitive global markets.

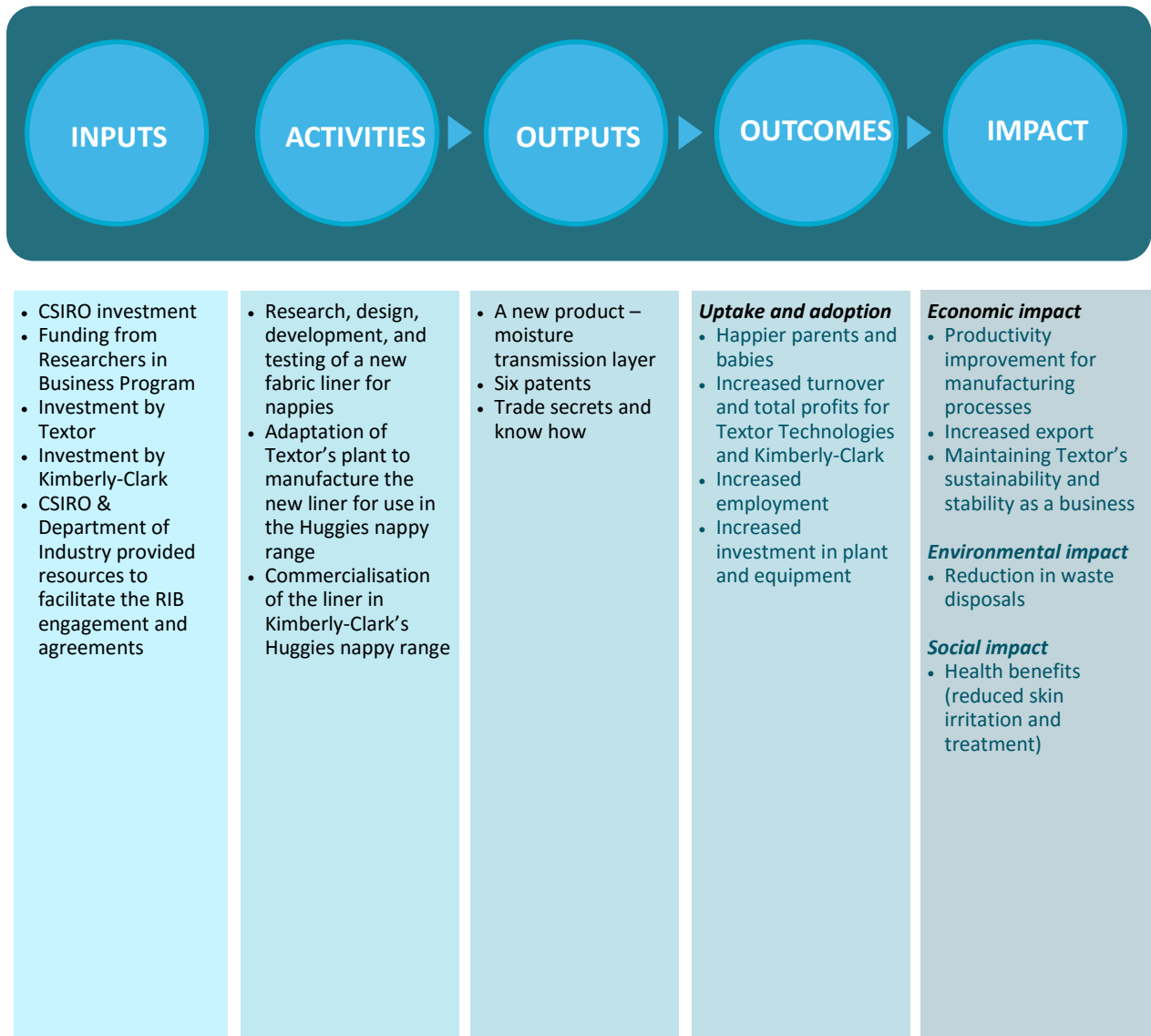


Figure 1: Impact Pathway for TEXTOR Project

2 Purpose and audience

This independent case study evaluation has been undertaken to assess the economic, social and environmental impact of CSIRO research into 3D nappy fabric undertaken with Textor Technologies. This case study may be used as a standalone report and also aggregated with other case studies to substantiate the impact and value of CSIRO's activities.

The report is provided for accountability, reporting, communication and continual improvement purposes. Audiences for this report may include Business Unit Review Panel, Members of Parliament, Government Departments, CSIRO and the general public.

3 Background

Approximately 300,000 babies are born in Australia each year. Around 40 per cent of these are born to first-time mothers. Research with first time mothers has indicated that one of their strongest challenges involves managing their young baby's very liquid bowel movements (Kimberly-Clark, 2013). The market for disposable nappies for young babies in Australia is around \$500 million per annum. Moreover, the global baby nappy market is growing, driven by rising birth rates and increased hygiene awareness across developing countries. Factors such as rising disposable income and shifting consumer preferences, along with demographic patterns have accelerated growth in developing markets.

The modern disposable nappy is a complex and sophisticated product with breathable outer covers, highly absorbent material on the inside, and shape designed to suit gender. IBISWorld estimated that in 2009, 5.6 million disposable nappies were used every day in Australia.

Nappies have traditionally maintained the same flat shape over time. Children who are fed mainly liquids in their first six months are prone to very liquid bowel movements that would normally leave residues on their skin. Kimberly-Clark, a global household brands company specialising in paper-based consumer products which has manufactured nappies for many years, recognised that traditional nappies were not always able to sufficiently protect a child's skin.

This recognition coincided nicely with the development of a new 3D fabric developed by CSIRO in partnership with Textor Technologies. Textor's alliance with Kimberly-Clark enabled it to demonstrate relatively easily that by using this new fabric it was possible to create a new nappy that better protected the health of a young child's skin. Kimberly-Clark has now extended the use of the Textor liner to its nappy products for older babies.

Textor Technologies, a Melbourne-based SME, designs and manufactures highly specialised non-woven textiles that are engineered for specific purposes. These are generally low margin products which are manufactured in high volume, with the company producing more than 100 million square metres of fabric annually. Textor is one of the key suppliers for Kimberly-Clark.

The dynamic global competition poses challenges for SMEs in understanding where their market is going and how to adapt their businesses. Novel ideas and proven technology can assist in achieving more effective and efficient processes. Australia's research sector has world-class

expertise and facilities, in partnering with SMEs it enables them to take advantage of market opportunities. CSIRO engages with such SMEs to through the SME Engagement Centre (now SME Connect Program). Since 2008 the program has helped more than 180 businesses grow and gain a competitive advantage through access to cutting edge research and technology.

Textor’s relationship as a customer of CSIRO began in the early 2000’s, and mostly consisted of small scale consulting and R&D services on a fee for service basis. Some of these activities included image analysis system development, consulting and service agreements examining carding efficiency, and non- woven processing. In 2010, CSIRO’s SME Engagement Centre engaged with Textor via the Department of Industry’s Researchers in Business (RIB) program (now Research Connections). The RIB program utilised resources from within CSIRO and other research organisations to enable the transfer of useful knowledge from researchers to companies participating in the program. This agreement formalised the placement of Dr Niall Finn, a nuclear physicist who spent the most recent part of his career working in industrial fibres and textiles.

4 Impact Pathway

Project Inputs

The collaboration between Textor and CSIRO was enabled due to initial grants from RIB, following which further annual agreements were made to maintain momentum and further demonstrate commitment to a deepening relationship. The final placement agreement was executed in the 2016-17 financial year, and expired contemporaneously with Dr Finn’s retirement from CSIRO.

Table 4.1 outlines the financial contributions to the Textor project in the period 2009-2017. Additionally, CSIRO’s workshop manufactured special rotating drums which Textor use to make the new product. The total cost of CSIRO’s workshop contribution is around \$38,000.

Table 4.1: CASH AND IN-KIND SUPPORT FOR TEXTOR PROJECT

Agreement	Revenue from RIB	Textor payments to CSIRO	CSIRO funds
1st Agreement	\$50,000	\$50,029	\$80,000
2nd Agreement	\$50,000	\$57,000	\$73,00
3rd Agreement		\$44,000	\$16,000
4th Agreement		\$44,000	\$16,000
4th Agreement		\$93,000	\$27,000
6th Agreement		\$147,000	\$93,000
7th Agreement		\$147,000	\$93,000
<i>Total</i>	<i>\$100,000</i>	<i>\$582,029</i>	<i>\$325,000</i>

Activities

Research and Development of 3D fabric

Textor had a well-established relationship with CSIRO prior to the start of this project. CSIRO staff from the Materials Science and Engineering section at Geelong had experience working with non-woven textiles and had equipment which was used to pilot the production of the new Textor Product.

Dr Finn's expertise enabled him to assist Textor develop fabrics with specifically tailored properties. In this case, his expertise was specifically applied to developing a fabric product which, when used in nappies, could make them softer and keep the wearer drier for longer periods. The research undertaken was focussed on developing a composite 3D fabric. The project focussed on the following key areas:

- Plasma treatment of acquisition layer materials for baby nappies;
- Development of a stay dry liner for a hygiene application and in doing so understanding the factors affecting wicking behaviour in textiles ;
- Development of an odour reducing component capable of an application to an acquisition layer; and
- New composite web structures for non-woven textiles in hygiene applications.

Some of the key research activities conducted during the partnership included:

- Development of 3D structured non-woven materials and methods for their manufacture;
- New methods of modifying surface chemistry of non-woven materials for enhanced performance;
- Development of structured thermally bonded non-woven materials for improved liquid distribution;
- Determining feasibility of the scaling process. This was proven through modification of the CSIRO pilot line to run at almost four times its original design speed. These experiments informed the design of new equipment and selection of material inputs and process parameters for high production rates at Textor; and
- Modifications and key specialised parts required for the production machine at Textor. This enabled higher manufacture speeds, allowing the 3D liner to be commercially viable.

Commercialisation of 3D fabric

The new 3D nappy liner was commercialised through Textor's major customer Kimberly Clark in Australia, the United States, South America and Russia, followed by other regions. After extensive laboratory and consumer testing, the Textor liner was chosen over other candidates, including prototypes designed by Kimberly Clark's internal non-woven development team. Kimberly Clark launched the liner through it Huggies branded nappies with an integrated marketing campaign including TV, print, online, sampling and instore activity to show the how the nappy compares.

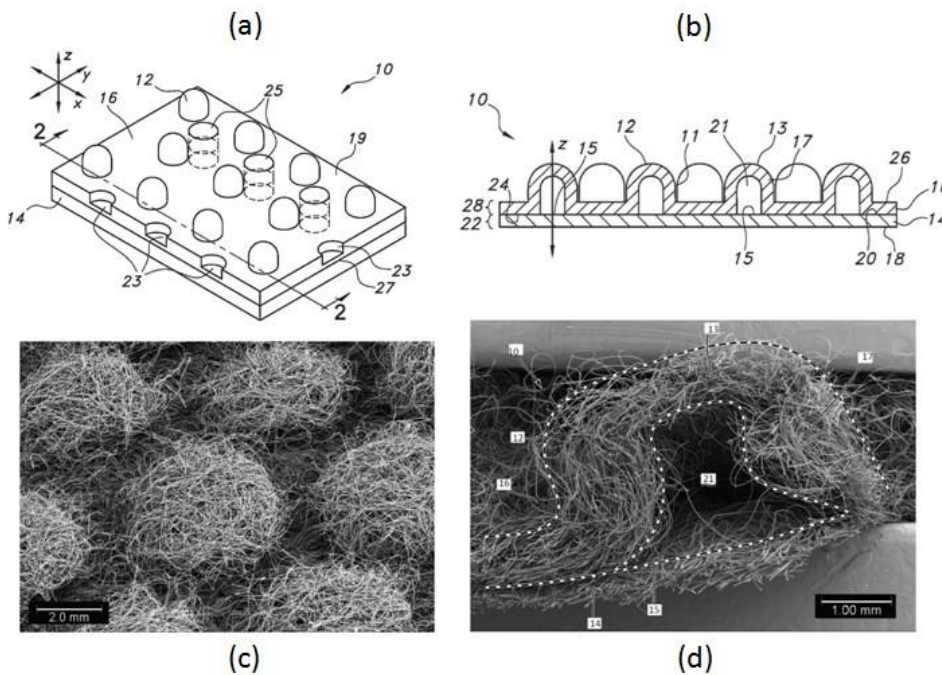
Outputs

The eventual output of the R&D from this project was a novel three dimensional (3D) fabric which formed a key component as a nappy liner for Kimberly Clark. It is a three-dimensional hydro-entangled composite that provides a unique combination of functional as well as aesthetic benefits not previously available in a baby nappy.

The fabric met several needs simultaneously. Some of the key properties of the fabric include:

- A three dimensional structure which keeps the baby's skin dry by providing separation between the skin and the super-absorbent core while simultaneously distributing the fluid rapidly and uniformly through the nappy;
- A gradient in hydrophilicity which keeps the surface dry and allows liquid to be drawn towards the core. Breast-fed newborns have particularly runny bowel movements and the structure is designed to reduce their spread within the nappy; and
- A material that is able to maintain the soft but resilient 3D structure while meeting stringent mechanical requirements was required in order to allow its endurance through the high speed conversion processes.

The two-layer composite provides this combination of properties through a web of fibres that is formed into the soft 3D projections while being simultaneously combined with the flat support layer through the hydro entanglement process. The support layer gives the strength and stability necessary for the later conversion processes, with the projections providing the in-product functionality and aesthetics.



Panel (a): A schematic diagram of one embodiment of the composite nonwoven 3D nappy liner showing the two fabric layers and the projections and apertures.
 (b), A cross-sectional schematic of the fabric structure showing the hollow projections.
 (c), Photomicrograph of the 3D nappy liner from above. (d), Cross sectional photomicrograph of the composite fabric.

Figure 1 : Technical figures from US patent 2014/0121626 Finn et al.

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Awards

The research has been recognised by the following awards:

- Kimberly- Clark Global Supplier of the Year 2011 to Textor, due to the success of the product in 3D UltraAbsorb Huggies Nappy.
- Most Innovative Product 2014 awarded by Out & About with Kids' Magazine for the 3D UltraAbsorb in Huggies Infant and Newborn nappies at the Melbourne Baby & Toddler Show .
- Sir Ian McLennan Achievement for Industry Award 2014 ' to Niall Finn, Phillip Smale, and Textor Technologies Pty Ltd. The award recognised the work of the CSIRO 3D Nappy Liner Team, highlighting outstanding contributions by CSIRO scientists and engineers to national development.
- AIRG Medal for Australasian SME Technological Innovation 2014 'to Textor Technologies Pty Ltd . The medal acknowledged the innovative methods used to produce the 3D fabric, which CSIRO co-developed with Textor.

IP/Patents

CSIRO's partnership with Textor has resulted in development of the novel 3D fabric, dubbed 3D UltraAbsorb. Kimberly Clark, who commercialised the product, hold all 6 patents covering the technology.

Outcomes

Since 2013, when the 3D UltraAbsorb liner was first implemented across Kimberly Clark's product range, it has continued to be marketed and received exceedingly well.

The beneficiaries of the technology have been Textor, Kimberly Clark, and the end consumers, who are, in this case are mothers and babies. Textor has expanded its capabilities to develop textiles that are more absorbent and comfortable, as well as increase its efficiency in producing large quantities. In 2014 Textor invested \$17 million to increase the capacity of the factory (Roberts ,2014) , typifying how important the product has been to their sustainability and viability as a business. The new product coupled with improvements in production process have enabled Textor to expand production and improved its competitive advantage over other rivals.

Kimberly Clark has benefitted from its relationship with Textor, having obtained new and innovative intellectual property, which has seen them incorporate the technology into their nappies globally. Initial consumer trials received an exceptionally high approval rating; and since its launch, consumer preference for the products have driven strong sales performance.

Market adoption

Irene Anast, Marketing Sector Leader- Baby & Child Care, Kimberly-Clark Australia, stated that of all the innovative consumer led features that have been developed for Huggies Newborn Nappies, the 3D UltraAbsorb layer has been the most exciting as it helps parents overcome the challenge of the liquid bowel movements during infancy before they are introduced to solid foods.

Box 1 Client Testimonial (Kimberly Clark)

This is an innovation so unique that we truly believe it will change the game of what a nappy can deliver.

We've experienced fantastic results from mums who tested the new nappy, which tells us just how much this innovation will mean to them and their babies.

We're particularly proud of how this innovation has been born locally in Australia through a very successful collaboration between Kimberly-Clark, our long time supplier Textor and the CSIRO. (Kimberly Clark, 2014)

Uptake has been extremely rapid

High adoption rates have been driven by strong consumer preference for the product. Kimberly Clark was able to hold its position as leader in premium nappies with the help of the 3D UltraAbsorb Technology, getting 70% approval from consumers during trials. In 2013 the total market for nappies grew by \$8 million, with Kimberly Clark being the biggest contributor to this growth. The strongest value growth of 2% was in the new born nappies/diapers category due to an effort by Kimberly Clark to attract consumers to its new innovative technology. The introduction of the product saw an immediate effect on the market preference of Kimberly Clark. In 2013 the percentage of value share of both Kimberly Clark and its brand Huggies saw a 0.7% and 0.9% increase respectively (Euromonitor, 2014).

Improved health outcomes

Infants under the age of two are vulnerable to developing skin irritation in the diapered region. Over hydration or prolonged skin contact with urine and bowel movements can result in the breakdown of the protective outer layer of the skin, resulting in irritation and the appearance of a rash. This inflammation or irritation in the diaper region is termed diaper dermatitis or diaper rash.

Diaper dermatitis is among the most common skin disorders during infancy, accounting for 10-20% of all skin disorders treated by pediatricians (Gregorio, 2015). Left untreated, progressive skin irritation in the diapered region which can lead to infections including candida dermatosis and bacterial infections, which require further treatment by a physician.

Extensive research has demonstrated that factors including chemical and mechanical irritants, skin pH, diet, skin over-hydration, skin occlusiveness, bowel movement consistency contribute to the occurrence and severity of diaper dermatitis. Conceptually, diaper dermatitis is believed to develop from fecal irritants on the skin which can mix with urine to increase the pH of the skin. Additionally resulting in skin breakdown and infiltration of the irritants into the skin.

Maintaining optimal skin pH is particularly important to protect diapered skin from the irritating effects of fecal enzymes. Clinical study results have indicated that disposable diapers containing Superabsorbent polymers, are associated with improved pH maintenance. Helping maintain pH in the diaper area helps reduce skin irritation, which in turn contributes to a reduced risk of diaper rash. The 3D UltraAbsorb, is a further development on these Superabsorbent polymers, and provides greater moisture wicking properties. Table 4.2 below summarises the findings of a study analysing the change in pH across different nappy types.

Table 4.2: Change in skin pH of different diaper types

Diaper Type	Change in pH
Superabsorbent disposable diaper	0.59
Conventional disposable diaper	0.9
Home laundered cloth diaper	1.16

Source: Counts et. Al 2014

Impacts

CSIRO's engagement with Textor via the *Researchers in Business* Program and secondment of Dr Finn has generated a range of impacts which can be seen in table 4.3.

Table 4.3: Summary of Textor project impacts

TYPE	CATEGORY	INDICATOR	DESCRIPTION
Economic	Product innovation	New products	The development of the 3D fabric has enabled Kimberly-Clark to bring a new world-class product innovation to market, which will benefit sales and market share, as well as

			further differentiate Huggies as the market leader.
	Productivity and efficiency	Productivity improvement	The partnership with CSIRO enhanced Textor's production processes. The focus of the business has changed from servicing the local markets in a range of general applications to being the best in the world in fluid transfer materials.
	Trade and Competitiveness	Exports	Textor is currently exporting around 70 per cent of its output from its Tullamarine site to most countries throughout the world. Kimberly-Clark has facilitated these supply contracts for their various nappy production facilities. Kimberly-Clark is exporting this Australian developed innovation into six other markets at this stage.
Environmental	Land quality and management	Waste disposal	<p>While the relative environmental impact of using disposable nappies has been the subject of some argument. A recent study indicates that the view among some, that disposable nappies are less environmentally friendly than reusable nappies, may be incorrect.</p> <p>An independently reviewed study in the United Kingdom in 2005 (Aumônier and Collins 2005), which was updated in (Aumônier et al 2008) assessed a wide range of activities associated with manufacture, use and disposal of disposable and reusable nappies which can affect the environment. The 2008 report concluded that:</p> <p><i>The environmental impacts of using shaped reusable nappies can be higher or lower than using disposables, depending on how they are laundered. The report shows that, in contrast to the use of disposable nappies, it is consumers' behaviour after purchase that determines most of the impacts from reusable nappies.</i></p>
Social	Quality of Life	Improved health outcomes	The unique 3D UltraAbsorb layer absorbs and contains babies' runny bowel movements and minimises the spread within the nappy, leaving a baby's skin noticeably cleaner, more protected, more comfortable with less incidence of nappy rash.
	Access to resources, services and opportunities	Employment	Textor currently employs some 50 staff. It is probable that many of these jobs would not have existed without the new 3D fabric developed in partnership with CSIRO.

5 Clarifying the Impacts

Counterfactual

If CSIRO and Textor had not undertaken this project, Textor would not have achieved the growth in its business and users of disposable nappies would be continuing to use a less satisfactory product. It will be difficult for Kimberly-Clark's competitors to match the success of the 3D UltraAbsorb product given that a strong intellectual property position has been established.

There are numerous nappy products, but not many of them can better protect the health of a young child's skin. Of particular concern for parents has been residues on baby's skin. Whilst conventional nappies will continue to be used in both Australia and globally, there is limited potential for improvements in nappies to protect a child's skin.

The counterfactual scenario describes what happens if CSIRO's 3D fabric is not implemented and the status quo or extension of current trends prevails. The counterfactual scenario includes the following two broad key elements:

- Limited adoption of 3D fabric technology to create a new nappy. Current trend of use of conventional nappies and associated negative economic and environmental impacts continue prevails.
- It will be difficult for Kimberly-Clark to match the success of the 3D UltraAbsorb product.

Attribution

The partnership with CSIRO has significantly improved Textor's production processes, turnover and notably led to the development of the new lining used by Kimberly-Clark in its nappy range.

The development of the technology used in the new nappies provides an excellent example of how CSIRO works effectively with different levels of industry in order to deliver innovation and improve competitiveness. In this case, each of the three parties brought crucial elements to help ensure the successful development and deployment of the technology. Contributions from each of these parties included:

- CSIRO brought its scientific expertise in textile technology, pilot-scale processing facilities, and high end mechanical fabrication capability to bear on the project.
- Textor made major investments (in time and equipment) and provided the capability to rapidly scale up and test the technology at high levels of production.
- Kimberly-Clark invested in a strong promotional and marketing program to promote the 3D technology in the nappies. This investment enabled the rapid deployment of the technology in the market place, and expanded the Australian innovation into other Kimberly-Clark markets around the world.

Based on the above, the attribution of identified benefits for this case study should be split evenly between CSIRO, Textor Technologies and Kimberly-Clark.

6 Evaluating the Impacts

Cost Benefit Analysis

It was not possible to prepare a formal cost benefit analysis for the Textor case study. The main reason for this is that both firms regard the figures on commercial returns as highly commercially confidential and I are not prepared to make them available.

The costs to CSIRO were approximately around \$643,000. The Australian Financial Review reported in February 2012 (before the expansion resulting from this project) that Textor's turnover was reported to be \$22 million (AFR 2012). As noted earlier, it is possible that in the absence of this CSIRO developed technology Textor's financial viability could have been threatened. Because Textor is not a public company, its turnover and profits are not publicly disclosed. However, the benefits achieved by Textor from this project are likely to be at least of the order of the firm's turnover, i.e. in the tens of millions of dollars.

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