"Engineering Challenges and Innovation in Power Engineering – Perspectives from my 2008/09 Vocational Employment Experience"

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A world without power transformers, what would that be like? You would not have the pleasure of watching that Friday night football match nor be able to fetch an icy cold drink from the fridge. Industries, shopping centres, homes would all be without power and the world would come to a complete standstill. Transformers play a pivotal role in assisting to supply power to billions of consumers worldwide; they are essential for our way of living. Whilst transformers have proven to be reliable and have a long life span, the transformer industry still faces the challenges of a carbon-constrained, dollar-constrained world. Some of the many factors, which contribute to these challenges, consist of climate change, fluctuating Australian dollar, supply-demand and shortage of engineers in the industry. This document encompasses information and statistics gathered from Wilson Transformer Company.

The power industry has seen vast changes in recent times and with ongoing challenges significant changes need to be made. The demand for power is growing at a rapid rate with the nation's population continually expanding. The growth is putting a lot of pressure on electricity supply and in turn creates demand for more transformers. Emphasis needs to be put on future forecasting to assess the needs of the consumer and ensure companies have the capacity and skill to meet those needs. Customers are also becoming more and more aware of conserving energy; therefore this poses competition in developing more environmentally and socially friendly sources of electricity.

For over 75 years, family owned Wilson Transformer Company (WTC) has dedicated its resources to developing, maintaining and supplying transformers, both nationally and internationally. WTC is renowned for supplying superior quality and reliable transformers whilst providing first class customer service. WTC has manufacturing plants in Woodonga and Glen Waverley and produces both distribution and power transformers. The Glen Waverley plant produces approximately more than 180 transformers per annum. WTC are extremely aware of all the future challenges and are continually enhancing their product as well as planning for the times ahead. This essay details these challenges and planned solutions.

Dynamic Ratings a subsidiary of WTC is one of many examples of innovative improvements for transformer enhancements. Dynamic Ratings established in the early 90's was developed to design a transformer management system. This technology is a cutting edge transformer control, monitoring and communication system. The hardware application reduces the risk of transformer failure and also extends the life of the transformer. Remote monitoring enables the customer to view the status of several diagnostic signals such as temperature and cooling system.

WTC is currently in the process of improving its production site in Glen Waverley to allow for the extra capacity. There has been greater than a 50% increase in demand since 2003. This is expected to continue and as a result, WTC have plans to increase their capacity by 40% within the next two years. There is currently a two year waiting period upon the order of new transformers; the new production plant should see the wait time decrease. The plant is expected to be complete within the next 18 months to two years.

However if the demand increases by 40% then supply needs to grow by 40%. The increased numbers in transformers will require extra materials, with some of those materials becoming harder to obtain due to the strong demand from industry worldwide. WTC has developed and maintained successful business relationships with its supply chain for decades. Their loyalty has been a key asset in ensuring continuity with these relationships. Wilsons plans to meet with suppliers nationally and internationally to notify them of their future needs. This will ensure suppliers can prepare for the extra capacity and develop future contracts.

"By developing closer relationships with our customer base, which leads to better organizational integration, we can better meet our customer's expectations and offer a service level that gives us a competitive advantage that distinguishes WTC from off-shore manufacturers." Malcolm Stewart General Manager said.

Currently a large percentage of transformer sale price consists of materials and components. 80% of the components and materials are supplied from overseas. This is where the Australian dollar has its effect. In recent times we have seen the dollar drop on a daily basis and now sits at an all time low. Short term this won't be problematic for the company however if the dollar continues in this fashion over the next two years the company profits could see a down turn. Unfortunately not all contracts are covered by price variation clauses therefore a quick swing in exchange rates could produce high losses for the company. On a more positive note companies that purchase transformers from overseas suppliers may now turn to Australian suppliers such as WTC due to the favourable exchange rate. WTC currently exports a small percentage of its transformers to international customers in particular the UK. Locally based companies would also find it more beneficial to source their transformers from an Australian company such as WTC. WTC is easily accessible by national companies and the issue of language barriers is also eliminated.

Materials are the largest expense in transformers, with copper being the most expensive. Price variations in materials are also a challenge the company is faced with. The price of copper in 1998 was approximately USD2000.00 per ton, however the cost sky rocketed to approximately USD9000.00 per ton in 2004. During this time the company faced losses due to fixed price contracts. The losses saw WTC become more hesitant towards offering fixed price contracts.

Another resource essential for transformers and cost effective is oil. Large power transformers utilize approximately 80,000 litres of oil. The price of oil also poses a challenge for the company. WTC has recently explored the option of a more renewable source of oil known as 'FR3' and has begun implementing this oil within their transformers. The oil is basically vegetable oil produced from canola seed and similar to the oil you use when frying your chips at home. The oil is proven to extend

transformer insulating paper life by five times or more (Cooper Electrical Australia, 2009). The product is relatively new and was introduced approximately five years ago. The oil is 100 percent biodegradable that means spills are non-toxic. This demonstrates WTC recognizes effects its product may have on the environment and are taking the appropriate steps to minimize the effect.

Industry regulations also take effect on WTC. Power utility companies are required to comply with the five-year regulatory period set in place by the Australian Electricity Regulator (AER). The five-year regulatory period determines the expenditure allowed for utility companies. The current regulatory period will finish in 2010. . Wilson's' needs to ensure they have enough room for capacity, then sell the capacity at the right price to have it paid off by the end of the current regulation period.

There is also pressure from regulatory bodies to ensure transformers are not overloaded. Each individual transformer is thoroughly tested to ensure minimal risk of error. Routine tests such as winding resistance tests, load losses test are carried out and required for each transformer. Type or design tests are also conducted and these are representative of other transformers and not included in routine tests such as temperature rise test. Special tests are also performed upon agreement between the client and company for example lightning impulse test (Also a possible type test). This particular test is conducted to confirm insulation integrity for transient voltages caused by either network faults or lightning. WTC has superior test facilities and continues to follow technology trends to ensure their test equipment is accurate and meets standards.

The consumption of energy on a global scale is growing at 2% per annum. The potential for long-term renewable energy is fast becoming desirable; however, due to uncertain cost restraints and lengthy payback periods, renewable energy is only being slowly implemented. However within the next 10-15 years we should see a rise in the use of renewable energy and therefore see the demand slow down for transformers. De-centralized generation along with battery-operated solar cells do not require the use of a transformer. A Melbourne based company has designed a backyard wind generator. The system is a four-meter high structure that consists of a silent vertical spin shaped in the form of a helix. The structure can even be designed to match the colour scheme of your home and even be used as a basketball ring. Developments such as these could potentially replace our current power network. Although there are cost restrains and to construct these structures in your backyard may need a permit.

Transpower a New Zealand based company states on their website that government predicts 90% of their power network to be replaced by renewable energy by 2025. Will transformers soon become obsolete? The short-term answer is no. There is the possibility of a slow down in the use of transformers however this is dependent upon the generation voltage of renewable energy sources. If the generation voltage is the required voltage transformers will not be required. Australia does have potential for various sources of renewable energy however New Zealand has an earlier start with hydro and geothermal energy.

Even though climate change poses a minor threat to the transformer industry, there are currently transformers being designed with alternative materials in order to resolve some of the shortage and also to improve the technology of the transformer. The department of Electrical Engineering and Computer Science, University of Canterbury has undertaken an overview in the research and development of transformers. A single-phase pole mount transformer was fitted with either silicon or amorphous steel cores and filled with either liquid nitrogen or oil. A loss performance test was then conducted on the transformer. This was followed by the design of a partial core transformer, which was immersed in liquid nitrogen and then tested for performance in air. The transformer was fitted with aluminium windings and was a replica of an anticipated high temperature-superconducting transformer. The final transformer designed was a high temperature super-conducting transformer. The transformer was constructed with the ability to adjust windings for different arrangements for both internal and external primary and autotransformer (Bodger, P.S, 2005, A glance into the future of transformers and beyond). WTC has explored this option however this alternative option is currently too advanced to be economically viable.

WTC also prides itself on employee satisfaction and ensuring staff are equipped with the skills to maintain and develop its transformers. In doing so this will guarantee staff are prepared for the extra workload. The company's willingness to take care of their staff is reflected in the number of staff members who have exceeded 20 years of service at the company. WTC is also looking to the future in aiding to resolve the issue of the nation wide shortage in engineers. WTC along with other companies in the power industry have paired with the Australian Power Institute (API) where WTC invests an amount in the order of $40,000.00 per annum. API states on their website that and 700-1000 graduates will be required over the next five years to meet growth and retirements in the industry.

WTC has dedicated company resources to ensuring the students of today acquire adequate knowledge through yearly paid vacation employment. This year WTC has provided an exceptionally well-organised program for the duration of one month. This program included factory tours for both the internal and external formation of the transformers with extensive information provided during the tour. Tutorials were organised to provide the students with the theoretical knowledge of transformer fundamentals and were highly informative. Students also had the opportunity to tackle minor projects in designated areas of the company such as testing and design. This task equips the student with skills which aren't taught in university; professional engineering skills. Students had the opportunity to practice these engineering skills in the business through weekly reporting meetings and a final oral presentation.

The challenges are an ongoing process although as described, WTC have already made significant changes and take pride in continuing to improve its business and goals. The company has made vital alliances with its clients, suppliers and the Australian Power Institute. This document describes that WTC has evidently demonstrated they are capable of adapting to change and recognize important issues such as climate change. Wilson Transformer Company has taken action to the tackle the shortage of engineers. The work experience WTC has provided has been exceptionally beneficial for both the company and students.