Countering the dire shortage of technical personnel in South Africa

by Tom Phillips, Inspired Interfaces

This paper details several challenges being faced by the power industry and will highlight how the judicious use of technology can mitigate against the damaging delays caused by resource shortages and offer solutions to the electricity transmission and distribution industry.

The power industry is under pressure due to the dire shortage of appropriately qualified technical personnel. From artisans to engineers, the industry has seen a decline in numbers making service delivery a very real and present challenge.

Mitigating this shortage we have seen an increase in the usage of various (software) tools aimed at improving productivity and guaranteeing design integrity. There’s no substitute for experienced technical personnel, but using design tools which assist engineers in the execution of their duties goes a long way in building confidence and experience.

An overview of some of the tools available for systems integration will give the hard pressed utility planning and projects personnel options on how best to manage their workload. Automating the repetitive operations affords more time for analysis and optimisation and the opportunity to execute other important tasks.

Valuable benefits accompanying the use of software tools include the creation of asset registers (complete with GPS location), customer service information, stock requirements, procurement bills of materials and budget tracking. In addition, alignment with master plans and network development plans can be managed.

The effective deployment of these applications contributes to capacity building within the organisation, and not only mitigates the scarcity of design personnel but improves cost effectiveness, the quality of designs and speed with which they are completed.

Resource issues

The multiplicity of government programmes (AgisSA, Jipsa, etc.) are clearly not achieving the desired results, leaving the country critically short of technical personnel to meet not only current demand but also South Africa’s economic grow targets. The failure of the Sectorial Education and Training Authorities (SETAs) to achieve their mandate of the Sectorial Education and Training of the Africas’s economic grow targets. The failure not only current demand but also South critically short of technical personnel to meet the desired results, leaving the country (AgisSA, Jipsa, etc.) are clearly not achieving the gap between scarcity of suitably qualified resources and getting the job done. Part of this solution is the deployment of specific software tools available in the open market.

These tools can never replace expertise and experience but do offer the over-worked engineer, technician and planning officer the ability to get the necessary work completed in the shortest period and with a minimum of fuss.

Our present situation

First let’s put some disquieting facts and figures on the table. The World Economic Forum Global Information Technology report (2013 – 2014) ranks the quality of South Africa’s education system 140th out of 144, and our mathematics and science 143rd out of 144 countries [1]. This is not the most ideal foundation for the creation of our country’s necessary technical resources.

Compounding the scarcity of learners with a scientific and mathematical background emerging from high school is the fact that SETAs have not been performing, and in particular the Electrical SETA. Table 1 shows company responses to questions raised regarding the effectiveness of SETAs (1 = SETAs are doing a poor job, and 5 = SETAs are doing a good job to a large extent).

TABLE 1: Satisfaction with the services of SETAs rendered (2002 to 2003) [3].

<table>
<thead>
<tr>
<th>Services</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Could not comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advice and support (learnerships)</td>
<td>34,5</td>
<td>9,8</td>
<td>18,0</td>
<td>8,2</td>
<td>4,1</td>
<td>25,3</td>
</tr>
<tr>
<td>Easy submission procedures</td>
<td>30,9</td>
<td>7,2</td>
<td>21,6</td>
<td>7,7</td>
<td>3,6</td>
<td>28,9</td>
</tr>
<tr>
<td>Internet site and web pages</td>
<td>35,1</td>
<td>8,8</td>
<td>15,5</td>
<td>4,1</td>
<td>4,6</td>
<td>32,0</td>
</tr>
<tr>
<td>Promptness in paying grants</td>
<td>33,0</td>
<td>7,7</td>
<td>15,5</td>
<td>3,1</td>
<td>3,1</td>
<td>37,6</td>
</tr>
<tr>
<td>Providing information about courses, programmes and training</td>
<td>32,5</td>
<td>8,8</td>
<td>21,6</td>
<td>6,7</td>
<td>5,2</td>
<td>25,3</td>
</tr>
<tr>
<td>Providing information about grants</td>
<td>35,1</td>
<td>9,8</td>
<td>20,6</td>
<td>4,6</td>
<td>2,6</td>
<td>27,3</td>
</tr>
<tr>
<td>Providing sector skills plans</td>
<td>40,2</td>
<td>9,8</td>
<td>14,4</td>
<td>3,6</td>
<td>2,6</td>
<td>29,4</td>
</tr>
<tr>
<td>Provision of free training not funded by employers</td>
<td>40,2</td>
<td>8,8</td>
<td>12,4</td>
<td>5,2</td>
<td>3,1</td>
<td>30,4</td>
</tr>
<tr>
<td>Response to queries</td>
<td>32,5</td>
<td>6,2</td>
<td>17,0</td>
<td>5,2</td>
<td>3,6</td>
<td>32,5</td>
</tr>
</tbody>
</table>

Further compounding the resource shortages Nick du Plessis suggests, “As it stands the industry has a large contingent of an older generation of artisans. There are younger people coming through, but the layer comprising people aged, say, late 20s to late 40s is very thinly populated. Training and workplace factors across the country have been in part responsible for this situation, as has immigration, with many artisans having left the country due to their skills being...”
in high demand internationally” [8]. The paper, “Engineering skills – key to effective service delivery” speaks of the collapse of artisanal training with the registered artisan’s average age being 55 years [2]. What we have is an abundance of aging qualified and experienced individuals with no-one to mentor or pass the baton on to so to speak.

From the HSRC report it is clearly evident that there is an undersupply in electrical and industrial engineers. Furthermore, the shortage of engineers from previously disadvantaged backgrounds remains strong and that these personnel are in high demand [9].

Amidst all these challenges the power industry, utilities and municipalities continue to deliver on their service delivery mandate, but with fewer personnel carrying a heavy load. Municipalities, large corporates, and consulting firms continue to undertake small, medium and large projects. South Africa’s engineering and technical versatility has seen many of our entrepreneurs (and corporates) spread their wings north of the Limpopo. It is interesting to note that in many of the contracts being undertaken off shore there are foreign based ex-South African technical (and managerial) personnel involved in these organisations, working alongside their South African counterparts. Visiting Jacobs Engineering Group in Perth, Australia during 2012 it was astounding to see that the majority of the projects, planning and design engineers were South African.

Solutions for transmission and distribution network planning and designers

The picture painted above is one that plagues the entire country, but our focus is on the power industry. What follows is a short discourse on software solutions which relate predominantly to those performing electrical transmission and distribution network planning, design and analysis.

For the personnel involved in the planning, design, analysis and implementation of electrical transmission and distribution networks help is at hand in the form of several powerful software packages. Some are more user friendly, some more integrated, while others focus on very specific aspects of electrical network design and analysis.

Many of the larger international corporates involved in network design and analysis have (over the years) developed their own proprietary software systems which are inextricably linked to their business processes and procedures. These products are not generally marketed to the local industry.

The design and analysis software systems available to the designers vary dramatically in complexity, as does their functionality and cost of ownership. I use the word ownership because these software applications are seldom purchased outright, but rather there is some form of annual maintenance or technical support agreement.

Local support and training is mandatory to get the most out of the packages. Like mobile telephones, one generally uses only a fraction of the true functionality and power of the devices – so too with the design and analysis software packages.

The supporting/peripheral software products, such as geospatial data systems (GIS), database systems (using either Microsoft SQL or Oracle) and computer aided design (CAD) packages (offering both 2D and 3D representation), though integral to the modelling and analysis packages being discussed will simply be mentioned. The most commonly used CAD packages are AutoCAD and Bentley.

Table 2 highlights the most commonly used electricity transmission and distribution network design and analysis software in South Africa.

![Table 2: Commonly used electrical transmission and distribution network design software.](image)

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<table>
<thead>
<tr>
<th>Software</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DigSilent</td>
<td>Has a comprehensive suite of power system products, with its PowerFactory being a highly integrated software package.</td>
</tr>
<tr>
<td>PowerFactory</td>
<td>ETAP is a fully integrated AC and DC electrical power system analysis tool with many modules offering functionality to suit.</td>
</tr>
<tr>
<td>ETAP</td>
<td>ReticMaster's software product suite is highly integrated and user friendly. The suite includes auto-generation of bills-of-quantities and costed bills-of-materials.</td>
</tr>
<tr>
<td>ReticMaster</td>
<td>Inspired Interfaces' software product suite is highly integrated and user friendly. The suite includes auto-generation of bills-of-quantities and costed bills-of-materials.</td>
</tr>
<tr>
<td>PowerOffice</td>
<td>PowerFactory has a comprehensive suite of power system products, with its PowerFactory being a highly integrated software package.</td>
</tr>
<tr>
<td>DesignBase</td>
<td>PowerFactory is a powerful software package designed for the design and analysis of electrical distribution networks.</td>
</tr>
<tr>
<td>Dapper Captor</td>
<td>SKM offer modules for three-phase power systems design and analysis, and software to coordinate protection device discrimination amongst several others.</td>
</tr>
<tr>
<td>CYMDIST</td>
<td>CYME engineering software solution is a module based package that covers distribution, transmission, protection and several other applications for power engineering solutions.</td>
</tr>
<tr>
<td>PAF</td>
<td>Schneider Electric's products include tertiary and industrial building electrical installation design software, LV electrical installation calculation aids and software to design modular and functional low voltage switchboards.</td>
</tr>
</tbody>
</table>

User friendliness of the design software varies dramatically between packages. While some are intuitive and the user can be up and running within minutes, others are more complex and require a fair degree of familiarisation before attempting to design and model a network. The more expensive products require a comprehensive amount of elemental technical data to be captured prior to simulation, often more than is available from even the manufacturer of the particular item, whether it be a cable, a motor, a capacitor or a transformer. In these circumstances the hard pressed designer has to guess the parameters, and he/she is often not in a position to make these estimates.

The one thing all the design packages do well is to perform repetitive, laborious calculations incredibly quickly. Complex networks can be designed, analysed and verified very quickly. Furthermore, the execution speed affords the designer time to play with “what-if” scenarios and perform network optimisation calculations. Some of the packages even have this optimisation functionality built in.

A feature that exploits the computational power of the computer is the analysis of multiple (induction) motor starting (Fig. 1). By
hand this is at best an estimation, but in the packages that feature this functionality it can be tuned to the nth degree. An absolute bonus when planning and designing industrial installations with multiple motors, variable speed drives and other non-linear loads. The analysis software affords the designer the opportunity to test and create optimum motor starting regimes.

Associated with the motor starting analysis benefits is the ability of some packages to perform harmonic modelling and analysis of the network. This facilitates the design of network filters to reduce the undesirable effects of these harmonics.

Core functionality to all the modelling and simulation packages are; load flow analysis, voltage drop calculation, current flow analysis, energy loss calculation, network balancing and fault current analysis. Several packages also include load profile analysis to assist with capacity planning. Several software vendors include the integration of protection devices whereby the package can assist with the design of appropriate discrimination. Furthermore, some packages incorporate conductor optimisation where the designer can design the most cost effective networks.

The most of the popular software packages offer a systems approach to design, some more effective than others. This linked functionality includes loading survey data for accurate as-built models or proposed network extensions, while others offer GIS integration and database management.

The power of these software packages can take a designer from raw field survey data to a completed, electrically validated and optimised design in a very short space of time. This frees the hard pressed designer to perform other duties.

There are software packages that offer project management and scheduling modules, while others include the creation of comprehensive bills of quantities and costed bills of material. It is not within the scope of this paper to go into the peripheral packages though.

Having expounded on what these excellent design packages can do we come back to the reason for this discussion, the critical resources shortages and inadequacy of training and mentoring. Many of the designers are ill-equipped to carry out the tasks demanded of them. This puts them in the precarious position of undertaking designs while not having the necessary wherewithal to instinctively spot errors and potential network failures. This is where it is imperative to have the right supervision and mentors to show them the best practices and guide the technical personnel in their designs (easier said than done).

Value added benefits

The incorporation of designs onto GIS/topographical maps facilitates the visualisation of the network and can ensure mistakes are not made, such as poles in the middle of rivers or dams, pole stays placed in the road, or cable spans running through buildings, to name but a few common errors.

Additional benefits include accurate asset registration, location and management. Once networks are completed it is very simple to create and manage an asset database of all the assets (Fig. 2), complete with GPS locations. This further assists technical services personnel when attending to customer queries and field fault reports.

Furthermore, the assets database makes the creation of maintenance regimens simple, particularly when it comes to transformers, HV insulators and the like. Technical personnel can easily compile works schedules for this maintenance, replete with asset GPS location. Once a network has been designed and captured into the network design package(s) analysing the constraints associated with line extensions and the addition of new loads is simple. Analysis also quickly highlights any marginal or overloading conditions, whether they are transformers being overloaded or cable capacity issues.

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Conclusions

Let us not sugar coat the situation we have in the electrical power industry in South Africa. We have challenges, economic, skills and personnel related that have to be tackled head-on. The hemorrhaging of highly skilled and qualified engineers, technicians and artisans from our shores has left a void that is not easily filled. Fewer skilled professionals mean fewer young engineers and artisans can be mentored and brought up through the ranks. Compounding the exodus of precious skilled personnel is the failure of our education system to train sufficient learners in the all-important sciences and mathematics.

There is no substitute for experience, but the judicious use of technology goes some way to alleviating the pressure the technical personnel are under.

It is imperative for South Africa to reverse the downward economic trend. The power industry cannot wait for the government and quasi-government organisations to find their way out of the quagmire. The industry has to take bold action to redress the shortcomings of the past and to be the catalyst for growth. In a recent AMEU meeting a counselor took an Eskom representative to task for their failure to meet the capacity demands in South Africa, calling on Eskom to take responsibility for their part in the poorer than expected growth figures for the country and to stop acting like a victim rather than one of the causes of the country’s distress.

Using the modelling and design software packages assists with network design accuracy, reliability, consistency and the use of standardised materials.

I’d like to leave the reader with a sobering thought that may seem to fly in the face of the skills shortage argument and negate the need for design tools that make work quicker, easier and more accurate. The reality is that there are dramatic changes in South Africa’s economic situation. South Africa is slowly losing its “powerhouse of Africa” status to countries to the north, in particular Nigeria. While the rest of the world is (cautiously) focusing on Africa for investment, South Africa’s credit rating is showing a negative trend. The scale of investment from Europe, America, China and Japan is impressive, but unfortunately the lion’s share of this investment is headed north of the Limpopo.

Those familiar with Clem Sunter’s scenario planning flag system may recall that in June 2012 he adjusted the percentages of the latest South Africa’s scenarios: Premier league, second division and failed state from 70%-30%-0% to 50%-40%-10%. In the discourse he pronounces that going into the second division would mean South Africa would probably lose its position in BRICS, access to international funds would become problematic and Nigeria would overtake South Africa as Africa’s largest economy by 2020 [6]. While SA is still a member of BRICS, Nigeria has overtaken it as Africa’s largest economy – six years ahead of schedule.

To add to this, we are seeing large corporates divesting their interests in South Africa, the latest being BHP Billiton divestment of their nickel, aluminium and other assets. We are witnessing widespread budget cuts and project postponements/cancellations. Anyone in the consulting and construction industry will attest to this. As a result, local companies are being forced to look for work elsewhere – and where better but to look into Africa. We have the inside track on the challenges of doing business in Africa, but it’s getting crowded.

In the final analysis there is a solution to the dire shortage of suitably skilled resources in transmission and distribution network planning and design in the form of the judicial deployment of these powerful software tools. Designs implemented using network analysis software are generally delivered quicker, more accurate, better optimised and cost effective.

References


Contact Tom Phillips,
Inspired Interfaces,
Tel 031 765-6650,
tom@interfaces.co.za