

https://dspace.org/

Software modules to further assist the rapid production of optimised electrical reticulation schemes

Rajakanthan, Thurairajah

2014-03-25
http://hdl.handle.net10539/14323

Downloaded from a DSpace repository. https://dspace.org/

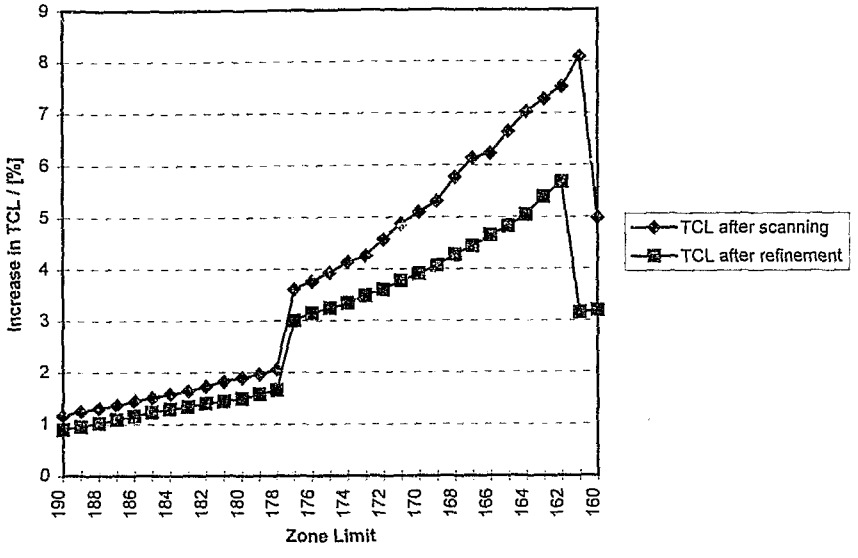


Figure 16 - TCL comparison for Township A (7 transformers)

The second example shown is for Township B and the results obtained are for the placement of 11 transformers. Again the steady improvement in TCL is visible and is more pronounced as the zone limit is lowered.

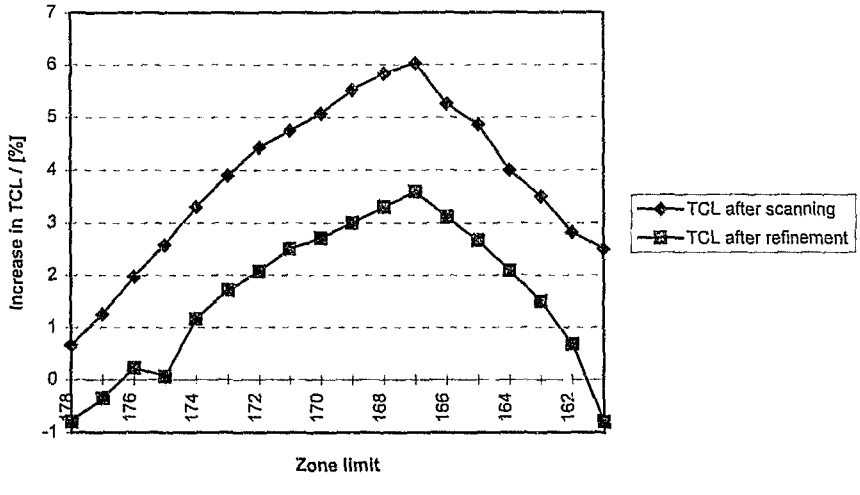


Figure 17 - TCL comparison for Township B (11 transformers)

The reason for the improvement in TCL being more pronounced at lower zone limit is straight forward. For higher zone limits, the number of consumers being transferred are minimum when the scanning algorithm is executed. Therefore, the number of exchanges that need to be conducted

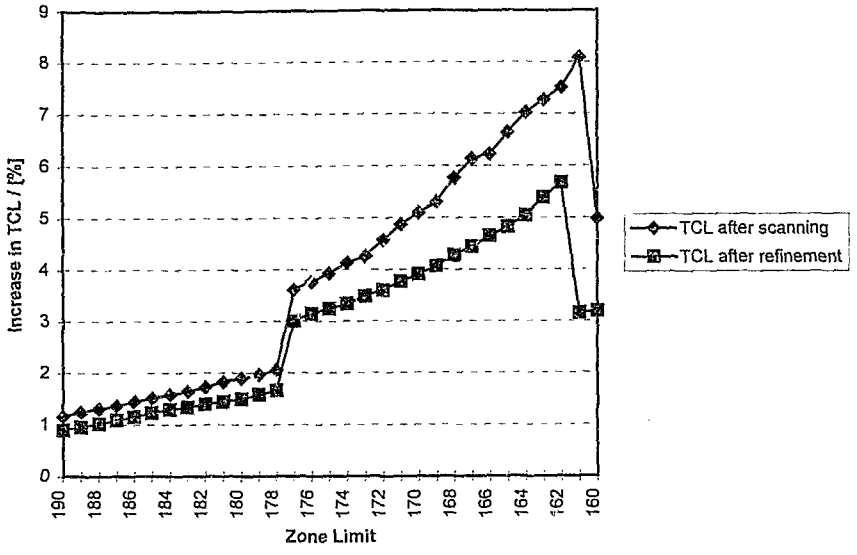


Figure 16 - TCL comparison for Township A (7 transformers)

The second example shown is for Township B and the results obtained are for the placement of 11 transformers. Again the steady improvement in TCL is visible and is more pronounced as the zone limit is lowered.

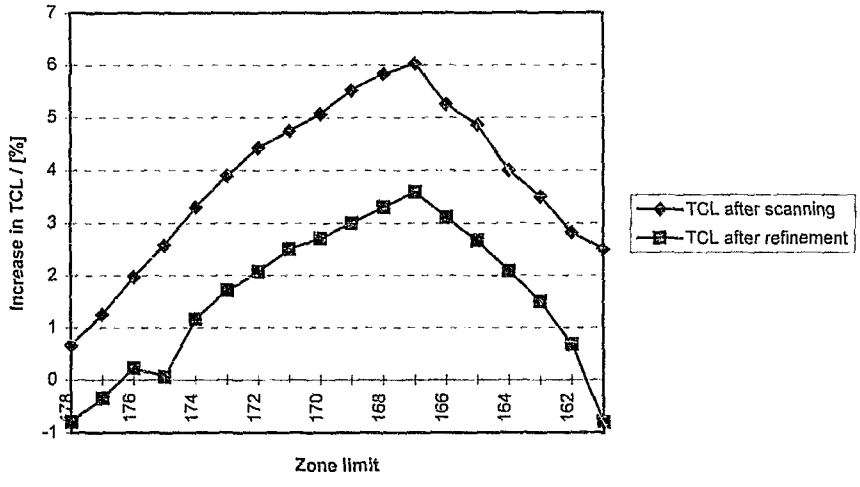


Figure 17 - TCL comparison for Township B (11 transformers)

The reason for the improvement in TCL being more pronounced at lower zone limit is straight forward. For higher zone limits, the number of consumers being transferred are minimum when the scanning algorithm is executed. Therefore, the number of exchanges that need to be conducted

are consequently minimised. When the scanning algorithm is being applied with lower zone limits, multiple sweeps are often required which leads to unacceptable zone deformation. Clearly for these cases, the improvement that can be brought about by the refinement algorithm is more significant.

It can be further noted that the improved in the TCL figure profile produced by the refinement algorithm closely resembles the TCL figure profile produced by the scanning algorithm. This property is true even though the figures generated by the scanning algorithm may vary unpredictably with the zone limit. A simple linear relationship between the scanning algorithm and refinement algorithm can be thus be predicted. The simple linear relation ship is limited to being able to predict whether a TCL figure produced by the scanning algorithm is greater or less than another figure without actually executing the refinement algorithm. Therefore, the refinement process need only be applied for the selected zone limit, once a complete profile has been generated purely with the scanning algorithm.

From the case studies it was found that some situations cannot be resolved adequately as the zone deformation was excessive. Significant zone deformation can occur when multiple sweeps are performed.

An example of such deformation is provided in Figure 18 which is the South-eastern corner of Township E. In this case the program was required to place 90 transformers (zone limit = 67) in the township. In this figure, the number next to the transformer location (signified by '+' symbol) represents the transformer number this case and is generated by the program. The transformer numbers are used for comparison purposes between this map and the other (shown in Figure 19) produced using the current refinement process (discussed in section 5.2).

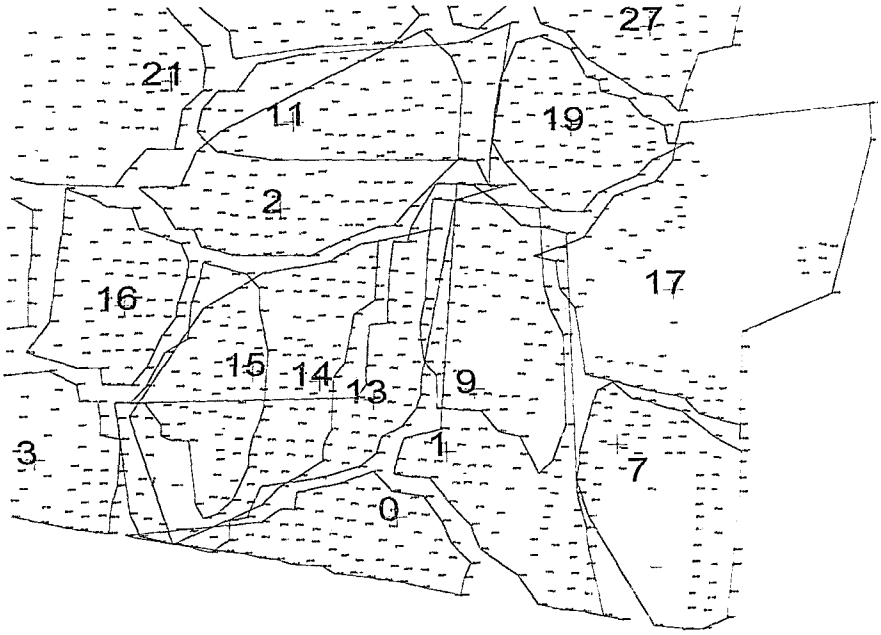


Figure 18 - Transformer zones generated using the post refinement method

It can be seen in this map that the transformer zones located in the central region are overlapping and severely distorted. This is the result of consumers being allocated to transformers across several other zones. This is clearly the accumulative result of the scanning algorithm, which had to make six sweeps to reach a solution.

The post refinement process made no significant difference to this region of the map. The refinement algorithm was not designed to resolve such a complicated consumer assignment. In order to overcome this shortfall and the excessive time requirements, the current refinement process was used and is evaluated in the next section.

5.2 Current refinement process

In this methodology, a single execution of the refinement algorithm is performed after every sweep (as opposed to exhaustive executions of the refinement algorithm after the scanning process as described above). In a single execution, it cannot completely resolve all the allocations, but it does limit the severe warping of the transformer zones to a sufficient extent. Using this technique, a solution can be reached substantially quicker than the post refinement method described above. The times taken for typical calculations have, on average, reduced below half. Calculation times are significantly less than half for cases that require single or double sweeps while the duration for those cases that require

multiple sweeps are just less than half. For example with Township D the time taken was as little as 10 seconds. For township E with smaller number of transformers and fewer sweeps a solution could be achieved in about 10 minutes. However, as the number of transformers being placed and the number of sweeps increases the computation time increases to about an hour (as opposed to 3 hours with the post refinement process).

While severe distortion is prevented by using the current refinement method, the differences in the final design produced by both methods are insignificant for most cases. The solutions produced by the current refinement method are just as good if not better than the post refinement method as far as overall zone formation is concerned. A comparative example is provided in Figure 19 to the same part of Township E shown in Figure 18. The improvement in the zone formation is obvious. Again, this example is used to show demonstrate an extreme circumstance.

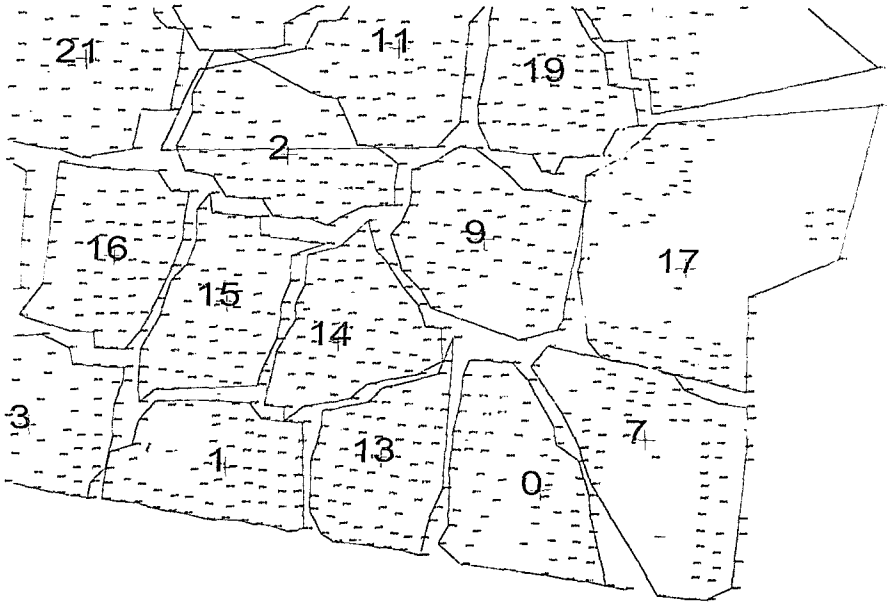


Figure 19 - Transformer zones generated using the current refinement method

It was found that despite the use of the refinement algorithm after every sweep there were still minor unresolved consumer allocations, as is the case with Transformer 11. This due to the fact that an exchange in consumer to transformer allocation occurs only if that will result in a reduction in TCL. In the case of transformer 11, the transformer zone is deformed as a result of one consumer that is located at the most westerly location within that boundary. The nearest transformer to that consumer is number 21. Unfortunately, there are no consumers within transformer zone 21 which can be better serviced from zone 11 resulting in a decrease in the overall TCL. While it is obvious to a human operator on

multiple sweeps are just less than half. For example with Township D the time taken was as little as 10 seconds. For township E with smaller number of transformers and fewer sweeps a solution could be achieved in about 10 minutes. However, as the number of transformers being placed and the number of sweeps increases the computation time increases to about an hour (as opposed to 3 hours with the post refinement process).

While severe distortion is prevented by using the current refinement method, the differences in the final design produced by both methods are insignificant for most cases. The solutions produced by the current refinement method are just as good if not better than the post refinement method as far as overall zone formation is concerned. A comparative example is provided in Figure 19 to the same part of Township E shown in Figure 18. The improvement in the zone formation is obvious. Again, this example is used to show demonstrate an extreme circumstance.

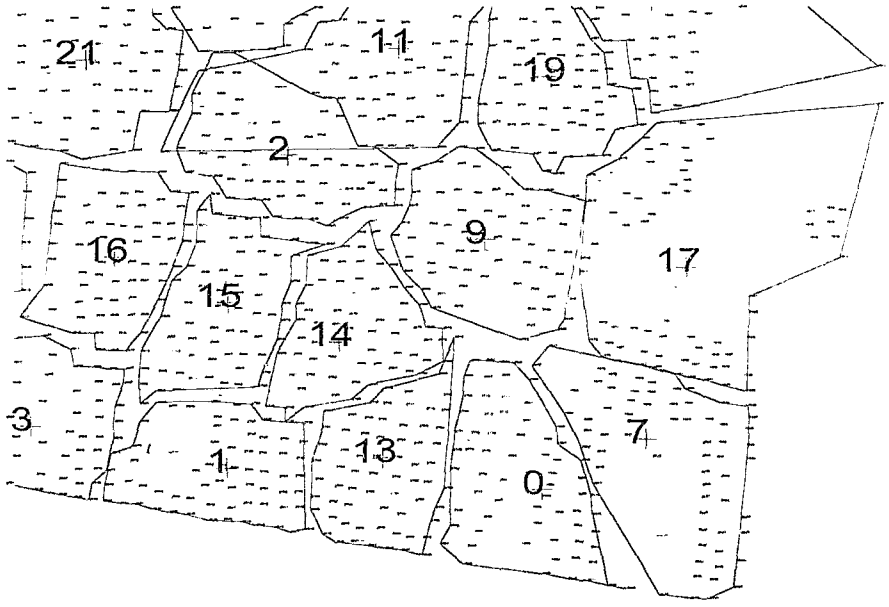


Figure 19 - Transformer zones generated using the current refinement method

It was found that despite the use of the refinement algorithm after every sweep there were still minor unresolved consumer allocations, as is the case with Transformer 11. This due to the fact that an exchange in consumer to transformer allocation occurs only if that will result in a reduction in TCL. In the case of transformer 11, the transformer zone is deformed as a result of one consumer that is located at the most westerly location within that boundary. The nearest transformer to that consumer is number 21. Unfortunately, there are no consumers within transformer zone 21 which can be better serviced from zone 11 resulting in a decrease in the overall TCL. While it is obvious to a human operator on

how best the situation can be resolved, it is a complicated task for the computer to determine exchanges over multiple zones.

Using exhaustive executions of the refinement algorithm after for every single sweep produced results that were marginally better. However, the improvement, if any, was negligible compared to the normal current refinement process. Furthermore, the time required to operate in this mode was prohibitively excessive (requiring in the order of 4 to 7 hours for Township B).

It must be also mentioned that the refinement process is not applied after any of the simulation sweeps. The reason for this is that the relationship between the TCL figures after a sweep and the refinement is predictable within sufficient accuracy. This conclusion was based on the results discussed in section 5.1. If a direction with the least increase in TCL is selected for the actual sweep, then the probability that refinement process would produce the greatest further improvement to the TCL is high.

Based on these findings described in this section, the current refinement methodology was chosen as it was practical when considering the computation time and its effectiveness trade off.

6 Costing profiles

The ideal number of transformers to be used in a particular township are solely dependent on the costing formula used and not purely on the calculations of the program. The reason for this is as follows. Straight line distances are used to approximate suitable transformer locations in the calculations. However, straight line distances do not vary linearly with the actual or feasible cable routes for varying zone limits. The relationship between the straight line distances and the actual or feasible routes to varying zone limits was established empirically and presented in the conceptual design (Doc No. A3). This was determined from transformer zones generated with varying zone limits in Township A. The estimates were made by actually measuring the most suitable routing paths. For this operation the software tool CART (which is briefly discussed in section 7) could not be used as it was not available at that time. Estimates were based on weighted distances for LV feeders and service conductors.

Based on the costing formula defined in the conceptual design the following profiles were generated for the various townships. The costing profiles are thorough for Township A and moderately thorough for Township B. A more efficient mechanism for determining the cheapest configuration was used for Township D and Township E. The behaviour of the cost with respect to the varying number of transformers for each township is shown in the graphs below. The raw transformer zone configurations, as produced by the software, are presented below the respective graphs. It should be kept in mind that the degree of refinement that the transformers zones have to be made depends significantly on the site visit since the feasibility of design can only be recognised at that stage.

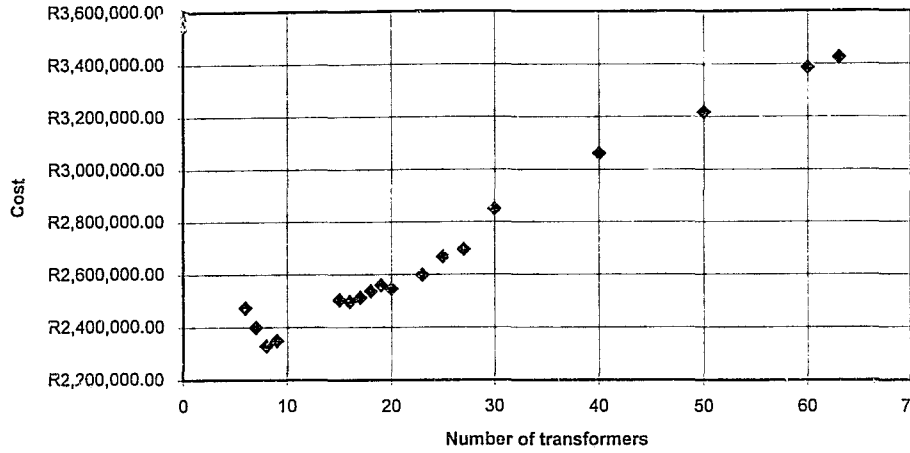


Figure 20 - Graph of number of transformers vs Cost for Township A

The cheapest configuration for Township A was 8 transformers. The design with the proposed transformer delineation is shown in Figure 21. In this township just the consumer locations and roads are shown. Note that the zone limits for each zone are also shown along with the idealised transformer locations represented by the '+' symbol. The roads are represented by the dashed lines. A few minor modifications may be required for this township but that depends on many factors that designer must consider to reach an acceptable configuration.

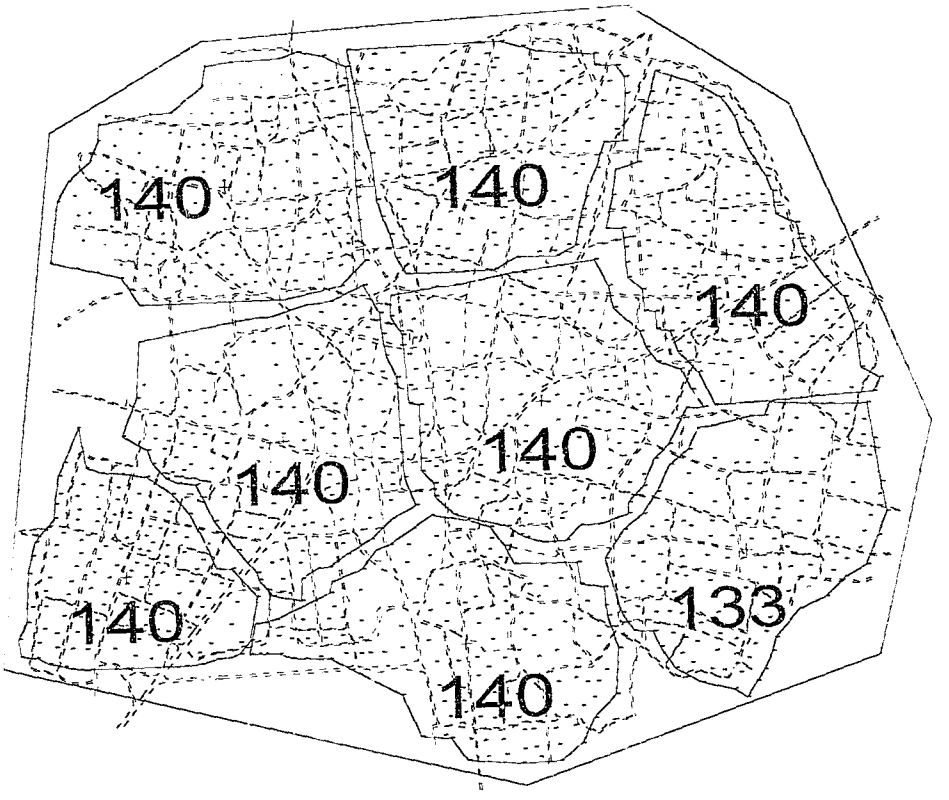


Figure 21 - Township A with 8 transformers

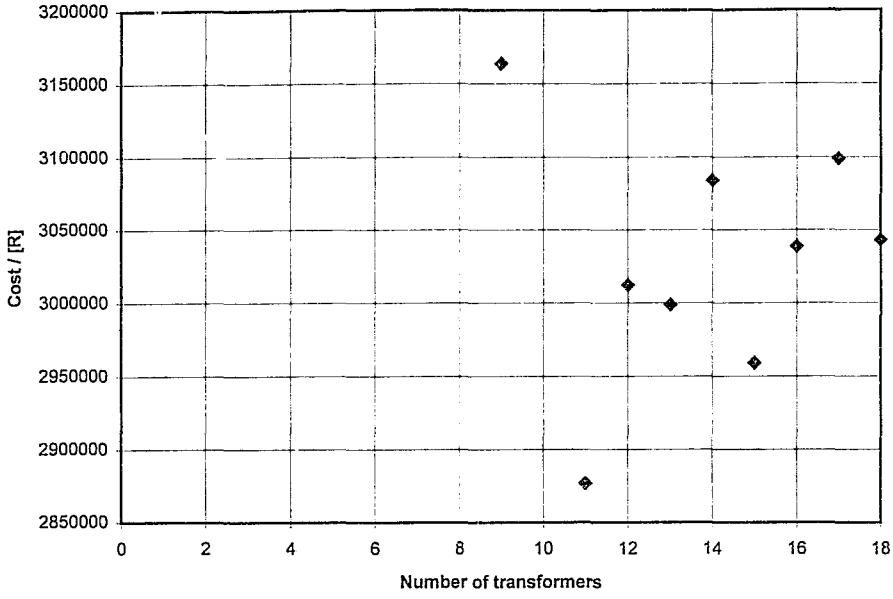


Figure 22 - Graph of number of transformers vs Cost for Township B

The cheapest configuration for Township B was 11 transformers. The design with the proposed transformer delineation is shown in Figure 23.

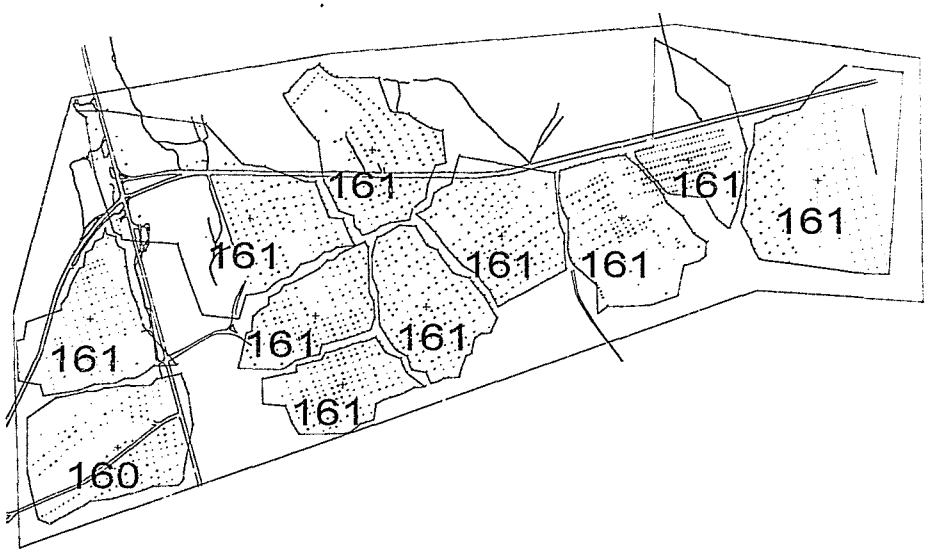


Figure 23 - Township B with 11 transformers

It can be seen for this township that a designer may make modifications to those zones located on the upper part of the township which cross the main road (represented by the double line).

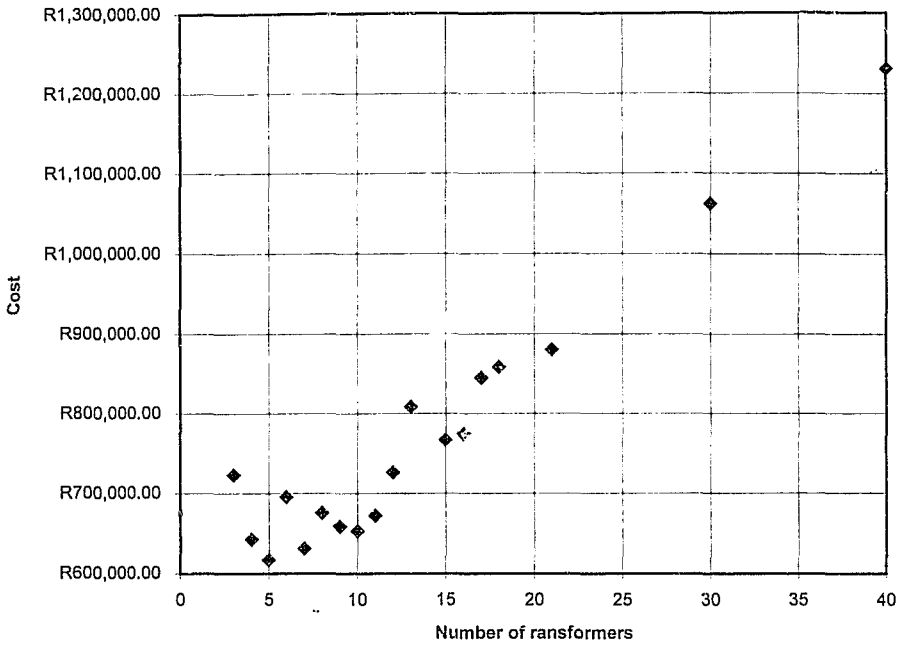


Figure 24 - Graph of number of transformers vs Cost for Township D

The cheapest configuration for Township D was 5 transformers. The design with the proposed transformer delineation is shown in Figure 25. In this township it can be noticed that the transformer zone on the top right spans across the unknown demarcated area. It is interesting to note that despite the obvious distances between the consumers, the program regards this as the configuration with the least TCL without violating the zone limit constraint.

The issue of how this matter will be dealt with by a designer is dependent on many factors. If that area is a lake then by moving the transformer a short distance to the right, the pole span distance can be reduced enabling a cable to be extended over that region. Alternatively, a designer may rearrange the zones so that the consumers above and below the demarcated area are serviced by separate transformers. There are many factors that can influence those two extreme solutions, and certainly solutions in between, are dependent on the layout of the township requiring the creative and strategic skills of the designer.

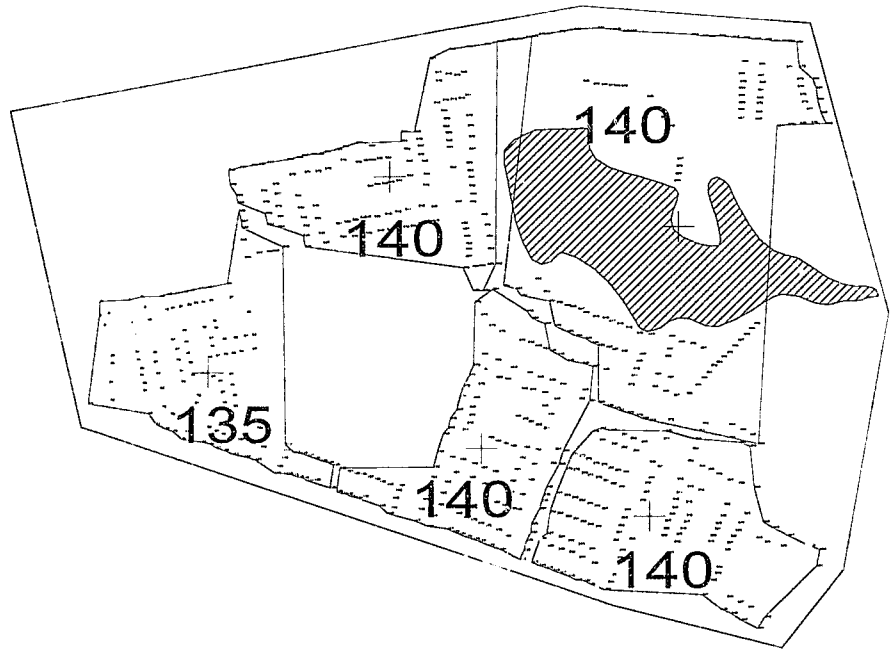


Figure 25 - Township D with 5 transformers

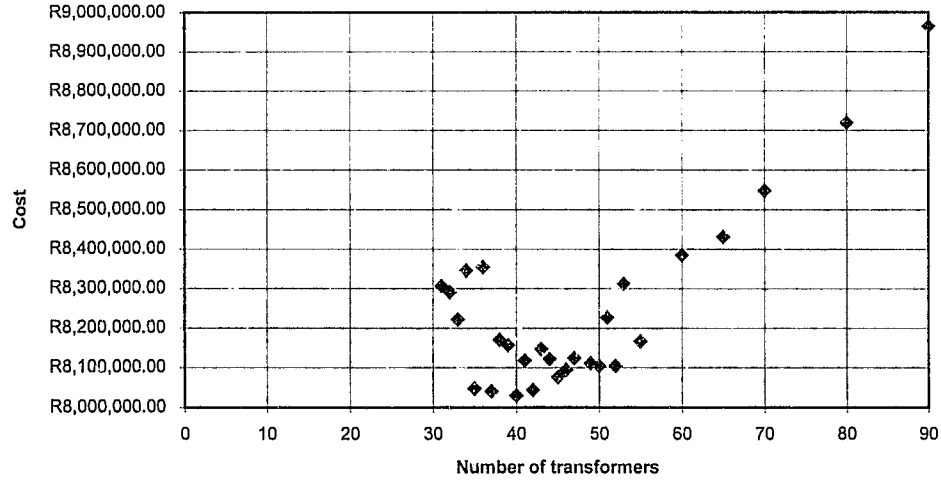


Figure 26 - Graph of number of transformers vs cost for Township E

The cheapest configuration for Township E was 40 transformers. The design with the proposed transformer delineation is shown in Figure 27. All the zones have 148 consumers except for those zones that have been stated. This map is quite busy but the information is relevant in

determining the effectiveness of the program. The only major modifications that can be foreseen is that the user may wish to separate those transformer zones crossing the main road (running vertically near the left hand side of the map).

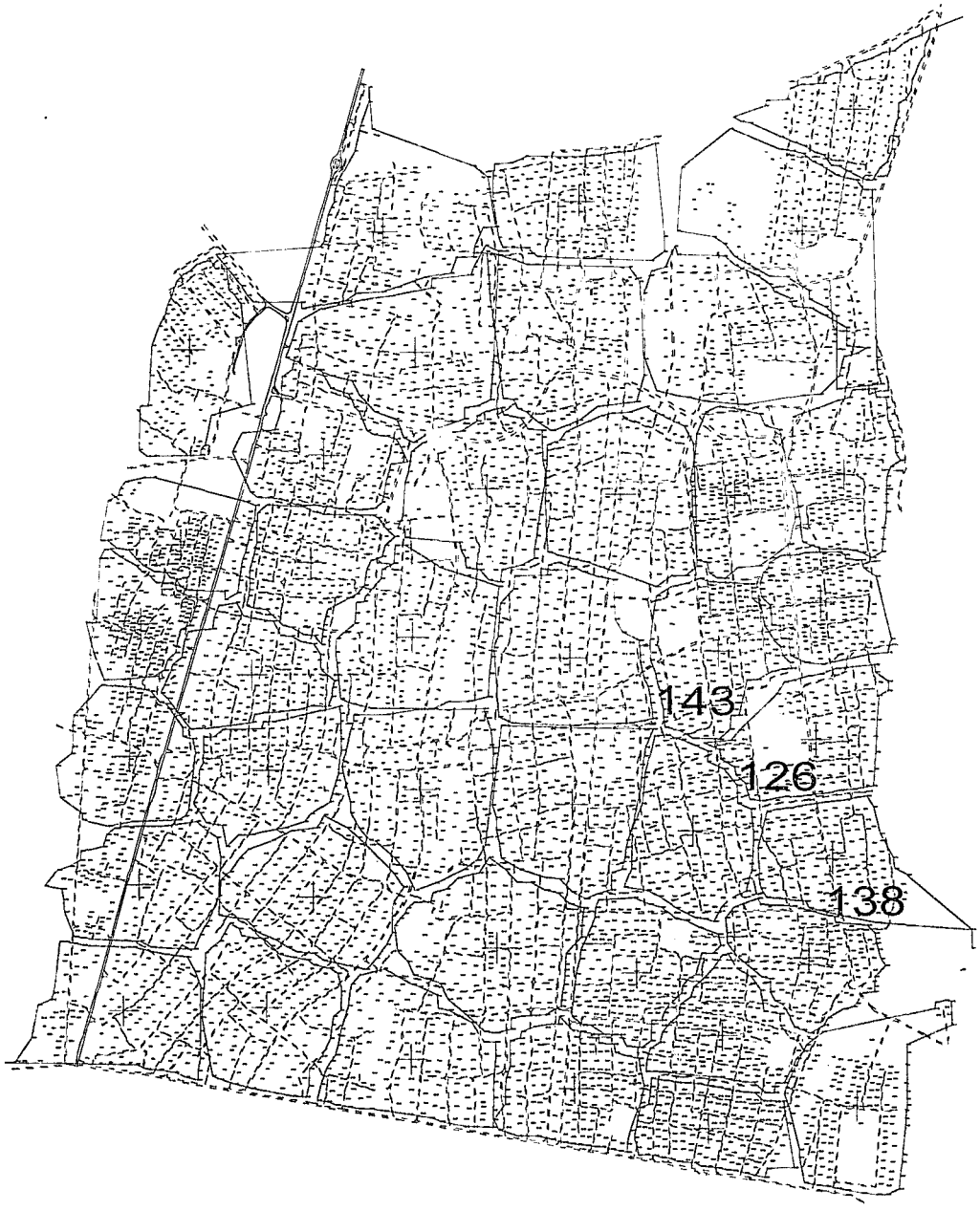


Figure 27 - Township E with 40 transformers

The issue of rotating and/or inverting the township through 90° was completely examined for Township C. The cost profiles for the eight combinations are provided in the graph in Figure 28 and were generated using the current refinement methodology. The legend for the graph in Figure 28 is as follows. *Normal* and *inverted* represents the map in it natural and inverted positions respectively. The *90r*, *180r* and *270r* represents the rotated positions of the map by that angle in the clockwise direction. The *90ir*, *180ir* and *270ir* represents the rotated positions of the inverted map by that angle in the clockwise direction. It can be seen that the cheapest cost is obtained for the *270r* configuration (normal map rotated by 270° in the clockwise direction).

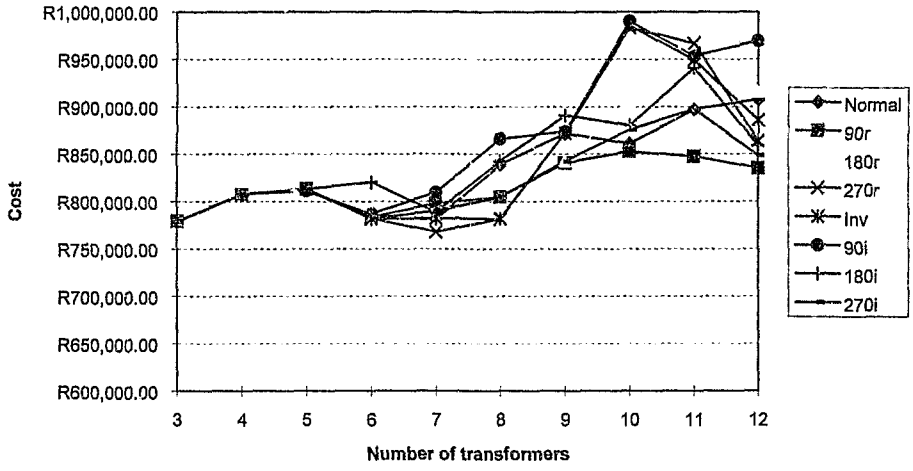


Figure 28 - Graph of number of transformers vs cost for Township C

For this particular survey it can be note that when fewer number of transformers are being placed the cost is virtually the same. As the number of transformers being placed are increased, the variation becomes more significant for the rotated and/or inverted states of the maps. It can be noted that looking at the curves it is impossible to predict its behaviour and therefore forecasting the best rotated and/or inverted state that would produce the best result is impossible, without conducting this complete evaluation. Interpolation or extrapolation of the results can produce acceptable results but only for a sufficiently short range.

The time taken to perform this analysis was about 3 hours and a significant portion of the time was spent in transferring information from the program to the spreadsheet.

7 Complete sample design evaluation

Complete sample electrification designs were done using a tool that was recently released in the market. CART [Dwolatzky:1998] is a tool developed specifically to assist engineers with the design of low cost electrification schemes. This tool is capable of calculating voltage drops, determining suitable pole configurations and producing a full bill of materials, provided that the complete design parameters have been specified. This tool requires an operator throughout the design process and is able to produce designs much faster that with conventional manual techniques. CART, though invaluable to the designers at present, does not incorporate the various automated optimisation routines that will be incorporated in ASED.

The purpose for using this tool to design complete electrical schemes that can be considered as a first draft by engineering standards is twofold:

1. Assessing the effectiveness of the transformer zones proposed by the software and measuring the level of modifications required for them to be considered acceptable.
2. To model the behaviour between the actual cost and the zone limit so that a meaningful comparison can be done with the cost equation proposed (complete discussion in Doc no. A3). This evaluation will reflect the ability of the cost equation proposed to determine the number of transformers that would produce the cheapest cost for a particular scheme.

7.1 Practical usefulness of this software

Three complete designs were done on Township C using the transformer zones proposed by this program. A few minor but obvious modification were made to most transformer zones. It was found, that using the proposed boundary to define actual transformer zones in CART made the task substantially easier, since it serves as a guide.

Since the township is relatively small, the usefulness of this software cannot be conclusively evaluated. For a small town, there can only be few realistic or feasible ways in which the transformer delineation can be done. When considering larger townships, naturally the permutations and combination increase substantially. Thus, the usefulness of this program for larger maps cannot be conclusively stated at this stage. The evaluation done on the small township suggests that it would indeed be useful in assisting designers a great deal in defining transformer zones. This complies with the requirement of the program which produces a draft configuration from which one can quickly make minor modifications to arrive at an acceptable layout.

To ensure that the costing for these schemes can be compared between each other, the same technology was used on all three schemes. All the zones had 50kVA 3ø transformers, 3ø 35mm^2 ABC (aerial bundled conductor) LV feeders, 4mm concentric service cables and 3ø squirrel MV feeders. LV feeder routing was pre-dominantly along mid-block and rarely along the street front. The following results were obtained for the placement of the stated number of transformers (all costs are provided in South African Rands):-

- Configuration 3: 3 transformers with a zone limit of 110 costs R659,769.38
- Configuration 4: 4 transformers with a zone limit of 80 costs R653,719.72
- Configuration 7: 7 transformers with a zone limit of 55 costs R718,885.83

A few observations on the designs were noted. Configuration 3 was found to have one zone that was not feasible. The feeder lengths were too great resulting in unacceptable voltage drops. Configurations 4 and 7 were feasible but the transformers were under loaded. The overall cost could have been further decreased if a few further modifications had been implemented to the transformer zones. This decrease may not be significant.

The LVCCF, MVCCF for the other designs were established, based on the sample designs that were done on Township C.

7.2 Cost equation comparison

This section discusses the attempts to prove (or disprove) the validity of the cost equation proposed. CART is able to calculate and represent the total number of poles, length of service, LV feeder and MV feeder conductors for each zone. Comparisons were made between the calculated values and the measured TCL to try and determine a meaningful relationship. However, no such relationship could be found, since the variations in the data gathered was excessive.

The main relationship investigated is the variation between total weighted[4] length of the service conductor and LV feeders in relation to the TCL. The average service length of the conductor per connection for the entire township was 44m while the standard deviation was 10.8. The average length of the LV feeder per connection was 38m while the standard deviation was 18.8. The average length of the MV feeder per connection was 9.6m while the standard deviation was 6. A useful relationship was

[4] The lengths of the various conductors were weighted by the cost of that conductor.

not exhibited between the cost per zone to the zone limit. Clearly, the variation in data is excessive implying that it is not possible to predict a relationship within meaningful accuracy.

The reasons for such a large variation in the data samples are now identified:-

- The area of the stands vary by as much as four times, and in some cases more. Thus, the consumer distribution also varies significantly, throughout this township. The larger stands require service conductors which was as much as 100m in length (used without violating voltage drop constraints).
- The township area is too small to conduct a meaningful evaluation. As stated earlier, when a township is small, as the one considered here, there are only a few ways in which the transformer zones can be delineated. However, when considering larger townships such as A, B and E the permutations and combinations increase substantially.

However, there was a measurable relationship between the calculated cost and the TCL. More specifically, a relationship was established between the cost per unit length of TCL and the zone limit. This was calculated by simply dividing the cost for the various zones by the TCL for that zone. This relationship is shown in Figure 29, represented by the jagged line. A third order polynomial was generated to roughly model the trend between the cost per unit TCL (in South African Rands) and the zone limit. Note that this polynomial is valid for the stated range:

$$20 \leq \text{zone limit} \leq 110$$

This polynomial was generated using Matlab™ software tool using the *polyfit* and *polyval* commands (details of this procedure have been omitted since they are not relevant to this discussion). The equation representing this smooth curve shown in Figure 29 is given below:

$$y = -2.93 \times 10^{-5} \times x^3 + 8.31 \times 10^{-3} \times x^2 - 0.789x + 33.2$$

where x is the zone limit and y is the cost per unit TCL. Note that further multiplying this figure by the TCL will provide the total cost for that scheme.

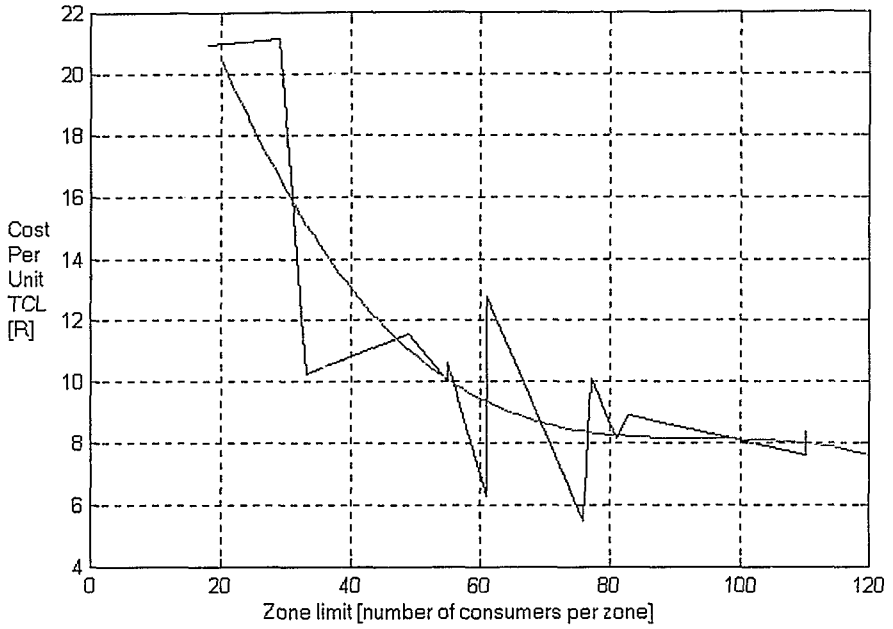


Figure 29 - Graph of zone limit vs cost per unit TCL

Using this polynomial, new costs were calculated for varying number of transformers and plotted in the graph shown in Figure 30. If a comparison is made between the graphs in Figure 28 and Figure 30, one can note a lot of similarity in the behaviour of the cost curves with one notable exception. The variation in cost is obvious for lower number of transformers. However, the prediction of the cheapest cost is identical to that identified by the cost equation.

Unfortunately, applying the costing model (represented by the polynomial) did not produce results that concurred with the prediction by the proposed costing equation. The cost estimates for other townships were found to vary unreasonably. The primary reason identified was the variation in consumer density and land occupation. Even if a thorough investigation is done by designing complete schemes with different number of transformers, it would not be possible to generate model that can be readily applied to other townships.

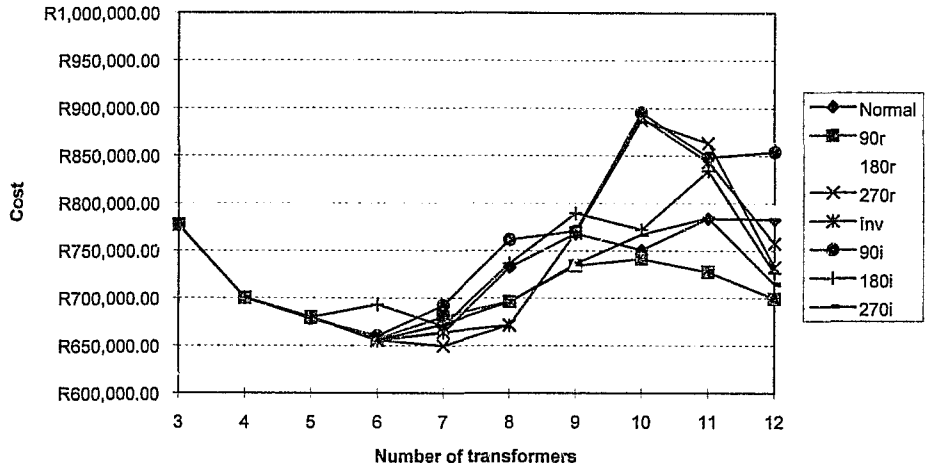


Figure 30 - Graph of number of transformers vs cost for Township C

Variation in the LVCCF obviously affects the cost of the scheme but does not significantly affect the cheapest option. For a very large township, the cheapest option may vary by a few transformers if there was a significant change in the LVCCF. For example, when the LVCCF was changed from 40 to 29 for Township E, the best option changed form 43 to 40 transformers. However, it must be recognised that these factors in the costing formula are only applicable to the specific technology and design style (mid-block or street front routing) to be used.

A complete design was done using the exact number of transformers and delineation as actually designed by a consultant engineer. Since the technology and style (mid-block or street front) used on the sample designs are different to the one that was actually designed, the cost figures may vary. Thus the same design philosophy will be applied to the design as the feature being evaluated is the transformer zoning and not on the best use of technology for a particular situation. Using the same technology as for the sample maps allows for meaningful comparisons to be made.

Based on the actual trials done, one can conclude at this stage, that this software will give some guide to the best transformer zone configuration for initial project assessment. Until proper testing is done with a variety of large townships with varying zone limits, it is not possible to state the accuracy or the usefulness of this product. Due to time restrictions, it was not possible to explore these aspects fully as stated. It does imply that a lot of work is required to design many schemes with varying number of transformers and technology. The permutations and combinations of the

available technology combined with having to work on a large map make this project no trivial task. However, the author is of opinion that its usage will greatly assist the transformer zoning process, saving a significant amount of time.

A completed sample design is provided at the end of this document including a spreadsheet detailing the bill of materials.

8 Comparison between Grimsdale's and scanning algorithm

A comparison was done between the results produced by Grimsdale's algorithm and the scanning algorithm (used in conjunction with the refinement algorithm). The difference in TCL was found to vary with the size of the transformer. The figures in Table 3 represent the increase in TCL after the execution of the scanning algorithm in reference to Grimsdale's algorithm. The figures are specifically for the best configurations proposed and listed in section 6.

Township	TCL increase after scanning algorithm.
A	1.8%
B	-0.8%
C	-3.7%
D	10.0%
E	1.0%

Table 3- Evaluation of TCL after the scanning algorithm with respect to Grimsdale's algorithm.

In the rest of this section, graphs of the various townships are presented with a concise discussion on the findings. It must be kept in mind that with all the graphs presented, the TCL calculated after Grimsdale's algorithm is taken as the reference. For the numerous executions of the transformer zoning program, the average zone limit was always specified based on the number of transformers being placed.

The variation is TCL for townships A and E is erratic and varies as much as 8%. In most cases the variation is under 3% for Township A which accommodates just over 1100 consumers. For this township, the majority of the points are between 2% and 6%.

For Township B it can be noticed that the TCL variation for 10 and 11 transformers is better than the results produced by Grimsdale's algorithm.

For Township C the map rotated by 270° was chosen as a sample. Due to the fact that this is a small township with varying consumer density and uneven land occupation, the variation in TCL is significant rising to over 20%.

The variation in TCL for Township D varies even more significantly from 20% to -50%. This township is also a relatively small and contains large areas of unoccupied land.

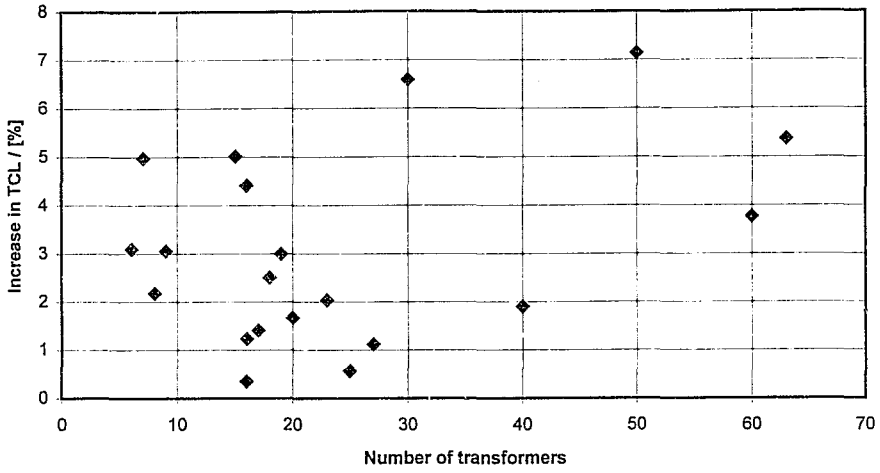


Figure 31 - Graph depicting change in TCL with varying number of transformers for Township A

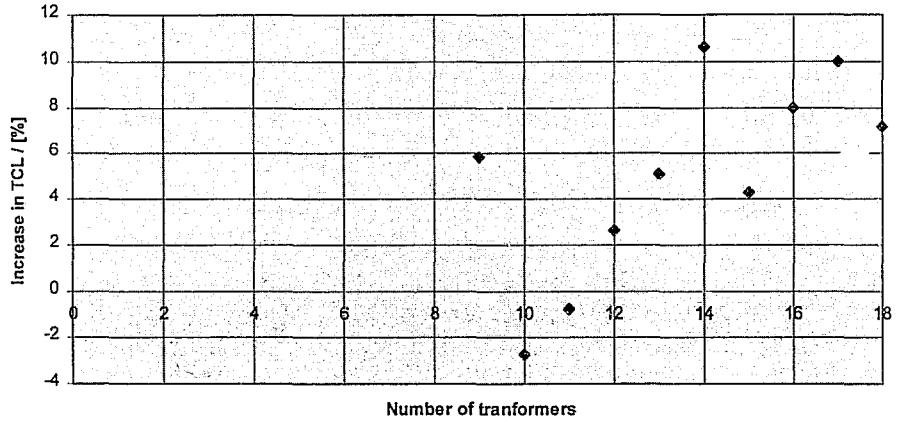


Figure 32 - Graph depicting change in TCL with varying number of transformers for Township B

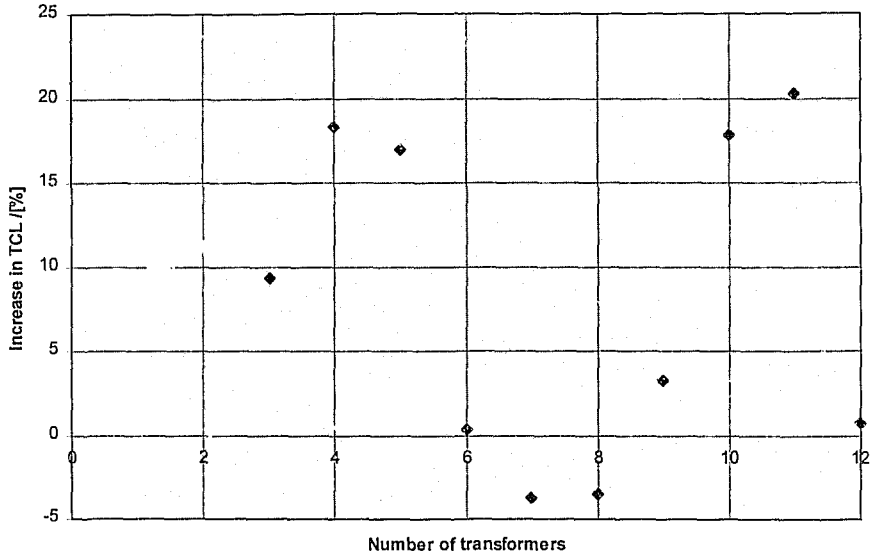


Figure 33 - Graph depicting change in TCL with varying number of transformers for Township C

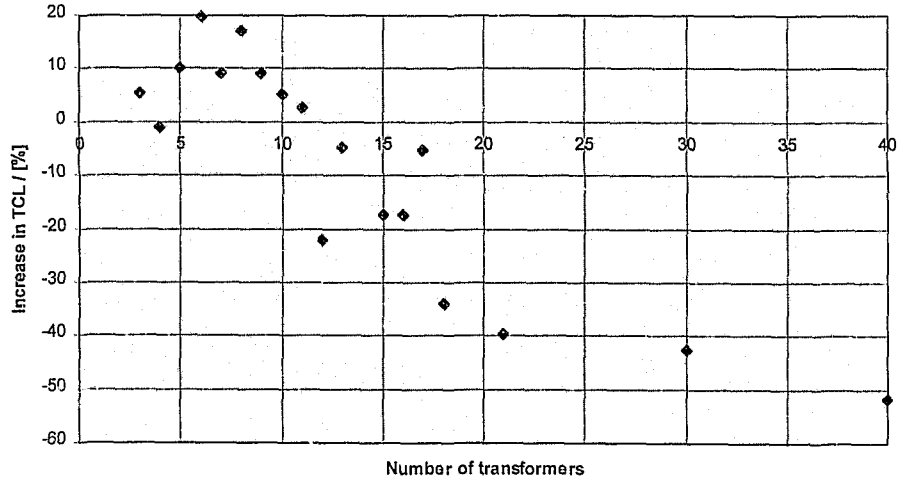


Figure 34 - Graph depicting change in TCL with varying number of transformers for Township D

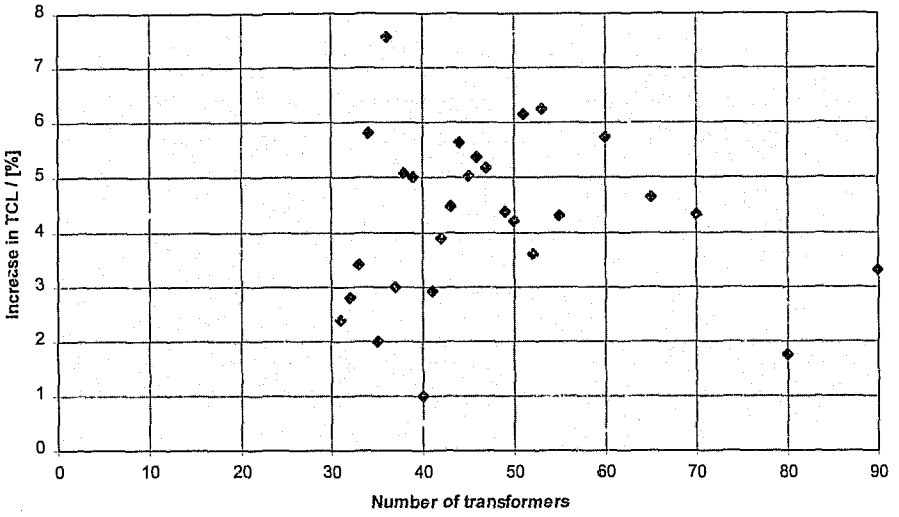


Figure 35 - Graph depicting change in TCL with varying number of transformers for Township E

Based on the vast amounts of data collected (in addition to those visually represented in this section), the difference in TCL is dependent not only on the size but also on the shape of the township. Generally, as the size of the township increase, the difference in TCL decreases. Despite the increase in TCL, the fact that must be established is that the zones delineated and the transformer locations identified using the proposed technique has minimised the TCL without exceeding the specified zone limit. In satisfying this requirement, the program makes an indisputable solution advancement to the one proposed by Grimsdale.

9 Evaluations

This document has presented, in great detail, the testing and results of the transformer zoning program. The subsequent sections summarises the contributions of the various algorithm used in the transformer zoning process. This includes the discussion on the costing formula used.

9.1 Grimsdale's algorithm

Grimsdale's algorithm was investigated in tow sections; the square extraction process and the consumer allocation process. It was found that if the map was rotated and/or inverted, bigger transformer blocks can be fitted within the township boundary. Bigger transformer blocks implies better starting positions for the transformers. It was further observed that the difference in the size of the transformer blocks became small if not negligible as the number of transformers being placed was increased.

Examining the effects of map rotation and/or inversion for the operation of the complete Grimsdale's algorithm produced some unexpected results. Rotating and/or inverting the map improves the results by a noticeable amount. Unfortunately, there is no way of evaluating the best square fit for the maps in one of its rotated or inverted states when large number of transformers are being placed. The definition of "large number" implies more than 1 transformer per 0.23km^2 area. It is not possible to evaluate the best square extraction that would provide the least TCL. Thus, Grimsdale's algorithm must be completely executed in order to determine improved transformer layouts.

Although Grimsdale's algorithm worked in the way it was originally designed, it was found to produce transformer zones that would be considered unacceptable. The primary reason for this occurrence is that Grimsdale's algorithm was designed for use in urban areas where the consumer density is sufficiently even. It is a well known fact that in South Africa the consumer density varies not only from one township to another but also within the same township. The time taken for the execution of Grimsdale's algorithm was not of any consequence.

9.2 Scanning algorithm

The scanning algorithm was developed to resolve the uneven consumer distribution generated by Grimsdale's algorithm. It is capable of "sweeping" in multiple directions, transferring consumers from one zone to another until the zones are evenly allocated. The direction determining technique that was used by default was assessing the number of consumers piled up at the end of a simulation sweep and assuming the

direction with the least figure. In the cases where there were more than one direction with the same number of consumers piled up at the end of a simulation sweep, the direction with the least increase in TCL percentage was used as the basis of selection.

Despite the other behavioural characteristics identified and listed below, the scanning algorithm was found to be reliable in converging at a solution.

1. The TCL did not vary in a manner with the zone limit that can be easily modelled or predicted. The behavioural characteristics are influenced by not only the township but also on the number of transformers being placed.

2. The time taken for this algorithm was not prohibitive, generally being in the order of minutes. However, as the number of transformers being placed increases, the computation time increases exponentially. The computation time is also dependent on the zone limit. As the zone limit approaches the average, greater computation times are required since more consumer allocations have to be resolved.

3. Several cases were found where the transformer zones had warped to an unacceptable state. This condition occurred in townships that were narrow so that it can only accommodate one or two transformers across its width. The problem for this type of township, referred to as ribbon shaped[5], was eliminated by rotating the map so that the primary axis of the township was either vertical or horizontal. The directions chosen for the sweeping algorithm would then always be along the primary axis of the township. It was found that this heuristic produced better results and did not cause as severe transformer zone deformation as with the township in its un-rotated or natural position. Even though many more sweeps are required than with the conventional sweeping method, the results produced were better.

4. On rare occasions it was found that repeatedly sweeping along the primary axis of ribbon shaped townships (as described the previous step) can result in the rate of convergence of the solution slowing down or coming to a complete halt. When this occurs, making a single sweep in the perpendicular direction and then resuming sweeping along the primary axis of the township results in the rapid convergence of a solution. The occurrence of this condition is extremely rare.

5. An interesting aspect was noted regarding the direction determining technique for the scanning algorithm that provided improved solutions.

[5] Ribbon shaped townships are ones that are long but narrow.

Suppose one is working with the scanning algorithm, selecting the direction for every sweep for transformer zones with zone limits varying from the maximum to the average. It is usual to note a pattern in the series of directions used for higher zone limits. It can also be noted that the first direction recommended for larger zone limits is different for smaller zone limits. It was found that if the recommended directions are ignored for smaller zone limits and the scanning algorithm is initiated with the same directions as used with larger zones, better results may be obtained. In order to do this, a pattern has to be identified in the direction specified by the scanning algorithm for larger zone limits and then to apply that to smaller zone limits.

This property is merely being classified and it does not always provide a better solution. For this reason developing a pattern recognition algorithm is not feasible and thus not recommended.

6. Consumers located near the boundaries of adjacent zones tended to be allocated to the transformer that was not the nearest. This not only resulted in the transformer zones being severely warped but also in the consumer allocations being inefficient. It was possible to identify consumers that were served by one of the transformers that could be better served from another and vice versa. This is an inherent flaw in the scanning algorithm where these errors are accumulated with each successive sweep. To resolve this situation, the refinement algorithm was developed. It should be understood that the refinement process is a necessity for the scanning algorithm and not an option in order to obtain valid solutions.

9.3 Refinement algorithm

The refinement algorithm was developed and two methodologies were evolved for its usage.

1. The post refinement method exhaustively executes the refinement algorithm once the scanning algorithm had completed its task. The refinement algorithm does make an indisputable improvement to the TCL. It was also observed that the improvement in TCL, though small, becomes more pronounced as the lower zone limit is reached. From the case studies, it was found that some situations cannot be resolved adequately as the zone deformation was excessive. Significant zone deformation occurs typically when multiple sweeps are performed. In order to overcome this shortfall and to reduce the excessive time requirements, the current refinement process was used and is discussed in the next section.

2. When using the current refinement process, a single execution of the refinement algorithm is performed after every sweep. In a single

execution, it cannot completely resolve all the allocations, but it does limit the severe warping of the transformer zones to a sufficient extent. Using this technique, a solution can be reached substantially quicker than the post refinement method described above. The times taken for typical calculations have, on average, reduced below half. However, as the number of transformers being placed and the number of sweeps increases the computation time increases as well. Since severe distortion is prevented, the solutions produced by the current refinement method are better than the post refinement method as far as overall zone formation is concerned.

9.4 Costing issues

The ideal number of transformers to be used in a particular township are solely dependent on the costing formula used and not purely on the calculations from the program. Since the TCL (used to approximate the transformer-consumer connectivity) does not vary linearly with the feasible cable routes for varying zone limits, a relationship was empirically established. Based on the costing formula proposed, costing profiles were generated for four real townships. The most suitable number of transformers recommended for each map was found to be reasonable. Since these are maps where electrical schemes have not been built, its impossible to draw any conclusions.

A complete cost profile was generated for Township C in all its rotated and/or inverted states (8 combinations) to investigate whether the cost can be further reduced. It was found that the cheapest design proposed was for one of the rotated states. Since the TCL was less for one of the inverted and/or rotated states, the cost was correspondingly less. This exercise proved that the cost of a scheme may be further reduced by applying the transformer zoning program to maps in their inverted and/or rotated states

9.5 Complete sample designs

Three complete sample designs were done using the same technology and style (referring to either mid-block or street front routing). Based on the cost figures produced for the various zones from these three designs, a cost profile was generated for unit TCL with respect to varying zone limits. To roughly model this cost formula, a curve was generated to best fit the data points. Comparing this cost curve to the profile generated by the proposed cost equation, a significant amount of similarity was observed. Both cost profiles identified the same map configuration as the cheapest cost. The general trend in the cost profiles for the placement of greater number of transformers were similar. The notable difference is in the trend with lower number of transformers. This accounts for the

difference in the cheapest configuration obtained from the complete sample designs and the theoretical proposal.

It was not possible to obtain feasible results by applying this empirical cost model to other townships. The primary reasons for this is that the consumer distribution and the land occupation varied significantly not only from one township to another but within the same township. This problem is compounded by the fact that the sample map (Township C) selected for evaluation suffers greatly from the flaw just described and was therefore a bad choice. This is especially true if it was meant to be used to generate a cost model for comparison to the one proposed.

A meaningful evaluation can only be done by doing complete electrical designs on a larger map such as Townships A, B and E. Many designs must be done using different number of transformers employing some common technology and style. Only then can the data be correlated and a useful costing profile be evolved.

10 Conclusions

With the series of algorithms proposed it is possible to achieve the primary objective of this research. The objective was to be able to produce a first draft in transformer zone delineation. The degree to which these algorithms accomplish the objective has been investigated through an extensive series of tests. The behavioural characteristics of this algorithm for the majority of the cases has been identified and classified.

The secondary objective of this program has been accomplished but not conclusively proved. The secondary objective is with regards to determining the optimum number of transformers that would provide the cheapest cost. Using the proposed costing formula, it has been difficult to prove that the scheme proposed is the best. The only indication with regards to the validity of program, is that the proposed schemes for the various townships tested can be considered reasonable or acceptable.

An attempt was made to prove the validity of the costing equation by doing a few complete electrical layout designs on a selected map. Due to time constraints, a map that was smaller than ones this program was designed for was chosen. Only when the results were correlated it was realised that the township selected was not good since the variation in consumer distribution and land occupation was relatively excessive in comparison to the size of the township. The costing profile generated from the complete sample designs was slightly different to the one proposed which was based on a much larger township. However, the proposed costing model is likely to be more accurate than the one based on the complete sample designs.

The time required for a single execution of the program for a normal sized township (500-2000 consumers) is not of any concern (a few minutes at most). When the township gets larger, the computation time increases exponentially and may be as much as an hour for 6000 consumers. Large townships with over 3000 consumers are rare in South Africa.

Other transformer zoning techniques investigated were not suited for third world countries, including South Africa, for the following qualified reasons. There is only a limited amount of information that is available to draftsman in terms of topography. Even the intelligent map cannot be considered as containing sufficient information as it is merely an extension of the standard CAD map intended for the comprehension of the software optimisation routines. Some techniques investigated require a list of known obstacles, feasible conductor routes and equipment positions. Due to the disorderly and remote nature of the low-cost housing areas in South Africa, this level of information is not readily available, expensive to gather and prohibitively time consuming to generate. Often, the practise is to

design a sufficiently accurate electrical layout for initial project assessment purposes and to then follow it up with a site visit. A designer is then expected to incorporate his or her findings within the design, prior to generating the final electrical layout, costing and bill of materials.

In keeping with this ideology this program produces a draft delineation of the transformer zones. Using this as a guide, a designer is expected to make any minor but obvious modifications to arrive at an acceptable solution. This is considered as the creative or resourceful aspect of the design work. The reasons associated with modifying the zone boundary are numerous and vary from one township to another. Clearly, the degree of refinement to the transformer zones is also dependent on the site visit. For these reasons, the author is of opinion that a software tool that can produce completely acceptable transformer zones can never be created for the conditions in third world countries. It is felt that this tool used in conjunction with the added feature discussed in the recommendations (section 11.2) will be useful. This opinion does not regard the ability or inability of the costing formula to determine the best number of transformers that would produce the cheapest design.

The original objective was to determine optimum transformer zones. What this program is capable of producing are near optimum solutions. The reason for that is the level of information and processing required to determine the optimum layout, especially when the design variables are influenced significantly by the layout of the township, is not practical. Minimising the objective function stated in the Conceptual design is merely a guide to the cheapest configuration for a given number of transformers. Since townships have many interconnecting pathways, it is logical to assume that the transformer locations determined by the minimised straight line distances are very likely to be the cheapest configuration.

Comparing the differences in TCL between Grimsdale's and the scanning algorithms, a notable difference can be observed between the two depending on the size of township. Generally, as the size of the township increase, the difference in TCL decreases. Despite the increase in TCL, the fact that must be established is that the zones delineated and the transformer locations identified using the proposed technique has minimised the TCL without exceeding the specified zone limit. In satisfying this requirement, the program makes an indisputable solution advancement to the one proposed by Grimsdale.

It was found that by inverting and/or rotating the map the TCL can be further minimised for a given zone limit and number of transformers. However, the best configuration that would provide the least TCL cannot be determined during the earlier stages of the transformer zoning process. No predictable pattern could be established between results obtained at

earlier stages of the process and the completed stage. Thus, the program has to be executed completely for the various combinations of inverted and rotated states of the township in order to determine the cheapest configuration. Unfortunately, for a large township, this implies a substantial amount of computation time and may be impractical at this stage.

Ultimately, feasible routes have to be considered when trying to accomplish optimum transformer zoning. When that level of information is available some of the existing or more likely new transformer zoning techniques can be considered.

In this research, it has not been possible to prove that the transformer zones produced does lead to cheaper and more cost efficient designs due to practical time constraints. An objective evaluation can only be made when ASED has been completed.

11 Recommendations

Based on the work done and discussion with some interested parties the following set of recommendations were identified and are briefly discussed.

11.1 OLE automation

In future, this product with all the other recommendations implemented, must be able to exist within an OLE automation environment. OLE automation will enable the creation of a seamless environment between a graphical front-end such as a CAD or GIS package. Thus, the user works on a graphical front end and the transformer zones are calculated delineated externally to the package and presented to him or her via the OLE automation interface. This is accomplished by exposing the relevant features as OLE objects so that they can be accessed and zones delineated by OLE automation controllers. The modifications to the zones can be reflected back onto the screen so that the user can evaluate them. A complete discussion of OLE automation principles is presented in document number A3 and will therefore not be repeated.

Accomplishing an OLE automation environment does not have any impact on the program and only the two classes that are responsible for input and output of information need to be rewritten (classes `Input` and `Output`). In doing so, it is important to ensure that the methods remain the same but the implementation can be different. This is one of the major advantages of using object oriented design approach.

11.2 Interactive zone correction

OLE automation provides a seamless environment that will make it possible to implement a useful feature for the manual zone correction process. Once the zones have been created, the user may inevitably have to make corrections to account for special features on the map. When a zone is modified and finalised, the program can then be made to re-delineate the remaining zones. Another zone can then be finalised and the remaining zones made to reform. Using this interactive process of finalising the zones and obtaining assistance for reforming the other zones, a designer can quickly modify the transformer zones into feasible allocations. Every time zones are reformed, updated consumer statistics can be displayed on a separate layer within the transformer zone so that precious time can be saved by not having to count the consumers located within the zones.

In order accomplish this, existing code can be used except the `Input` class has to be further modified (as per modifications described above) so that when the consumer co-ordinates are read in for subsequent processing those consumers that are located within the finalised zones are excluded. The output would be as before but the previously created transformer zones and statistics are erased prior to the new information being written.

11.3 Map inversion/rotation

It is has been proven that inversion and/or rotation of townships provide improved results. It has also been shown that manually performing such as investigation is a time consuming activity. Manual data gathering involves transferring information generated by the program, and inputting into a spreadsheet for evaluation. Automation can provide results much quicker, but that option must be available to the user. Performing a through investigation for Township C took about 3 hours and can be easily accomplished in under 30 minutes (estimated) if the data was gathered internally and output to a formatted text file. This data can then be simply read into a spreadsheet and a graph generated so that the minimum cost configuration can be determined. With the availability of OLE (object linking and embedding) the graph can be generated automatically by the program without invoking an external spreadsheet. The program can then be made to calculate that particular configuration (degree of rotation/inversion) with the average number of consumers or some greater number as deemed appropriate by the designer.

This feature require modifications to class `XfrBlock` and `XfrBoundary` to account for the rotated map. For the testing of the maps, the maps were rotated and/or inverted within the CAD environment prior to exporting. In this case the rotation and inversion will be self contained and extra code will be required to account for the rotated or inverted states of the map. This ensures that when the information is output, the original references are maintained so that the map created will be in its original position.

11.4 Improved costing

In order to confirm the costing formula a labour intensive study is required whereby a sufficiently large township is obtained and complete electrical schemes are done for varying number of transformers. Using this data a costing profile can be generated which can then be compared to the one proposed. If necessary, the proposed costing formula can then be modified so that it can more accurately serve in accomplishing the secondary objective.

For evaluating the costing profiles using this prototype, an external spreadsheet was used so that numerous costing equations can be investigated. The final product will provide the facility for the user to change the constants for the calculations such as the low voltage cable cost factor (LVCCF) and so on. This information will not be "hard-coded" and can be changed easily by any organisation for whatever reasons.

The cost formula does not include maintenance costs and no-load losses. The maintenance costs can be assumed to be a percentage of the capital costs. For example, Ben Dov [1987] assumes a 1.5% maintenance costs for urban distribution planning in Durban, South Africa. It is recognised that maintenance cost for high quality distribution systems are likely to be higher than rural areas. Specific figures are not known for rural distribution schemes especially since the distribution technology used is vastly different.

Penalty factors must be added to the cost function to account for the no-load losses that would be incurred at the transformers. It is well known that the peak design load lasts for a few hours daily. Most of the time, the transformers are not operating at peak load resulting in energisation losses. This loss, though small must be accounted for since they may become significant over the planned horizon period. Unfortunately, this is not a simple task as it implies that the load profiles for rural areas are required. Load profiles are complex as they must include some form projection. i.e the projected growth rate over the horizon planned. It is also noted that he likelihood of the projections being wrong are high. However, incorporating some form of projection into the costing calculations will improve its accuracy or at least model it more realistically.

11.5 Use of different transformers

In creating a complete cost profile a single sized transformer is used. If a list of transformers were available with the maximum number of consumers that it can supply for a particular ADMD, then the program can automatically select transformers as the zone limit decreases so that the costing profiles are more useful.

11.6 Use of different sized transformers within a single execution

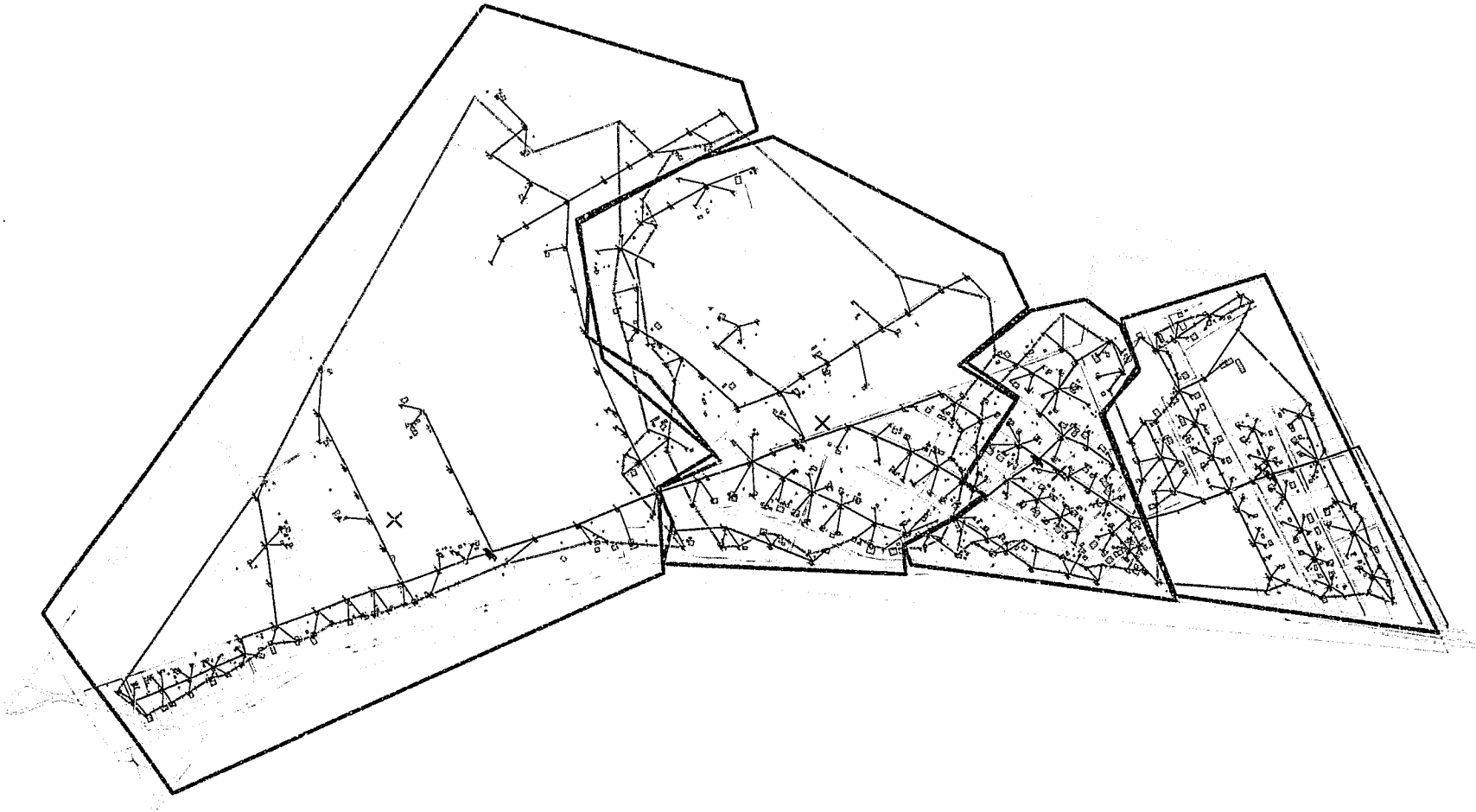
The use of different sized transformers within a single execution of the program is not supported in the current version of this program. Currently, with increased usage of smaller transformers, it is not uncommon to find different sized transformers within one scheme. Although this problem is more complex, techniques to effectively determine suitable transformer sizes to suit areas of different consumer densities must be investigated.

Sample Design

This section provides details of one of the complete designs done, using the transformer zoning tool, during the testing phase. The following page contains the design layout followed by the bill of materials. The design was done using the tool CART that was recently launched and currently being used in the design of Eskom electrification projects. The spreadsheet contains CAD codes that represent materials as used by the Eskom Distribution Technology department. These codes represent drawing numbers of structures with certain options. In order to interpret these codes, it is necessary to obtain the CAD code tables from ESKOM.

Since the map has been fitted for compactness on an A4 page, a brief description is now provided on the layout of the township. There are four transformer zones used within this township. It should be noted that the township had been rotated so that the largest size can be fitted on A4 sheet. The light brown boundary represents the boundaries as generated by the program. The blue boundary lines represent the transformer zones as drawn in CART. It should be noted that CART requires all the connections to be serviced to be encompassed by a transformer zone. If one examines the areas that are located between transformer boundaries, one can observe the changes that have been made to the transformer zones as proposed by the software. The '+' indicates the idealised transformer locations. The actual transformer locations are also quite close to the proposed but obviously at practical positions. These positions can be identified as those from where the feeders are radiating.

It should be recognised that this is a relatively small design where the possible ways in which the transformer zones can be delineated are minimum. In a larger townships the effectiveness of this tool will be evident as the possible combinations increases.



swart 4 xfr pro

Transformer Zone	All Zones	tr02	tr01	tr03	tr00
Connections	302	83	77	81	61
Total Material	420859.72	93793.24	87161.65	121715.59	118189.24
Total Labour	232860.00	50111.25	48236.25	70378.75	64133.75
TOTAL	653719.72	143904.49	135397.90	192094.34	182322.99
Cost per Connection	2164.63	1733.79	1758.41	2371.54	2988.90

MATERIAL COST BREAKDOWN

Worksheet					
Conductors and Cables	182987.55	34361.95	31196.23	55150.69	62278.68
Service Connections	128903.40	31330.26	29874.03	39222.96	28476.15
#REF!	0.00				
#REF!	0.00				
Poles and associated equipment	108968.77	28101.03	26091.39	27341.94	27434.41

LABOUR COST BREAKDOWN

Labour Cost Factor = **250.000**

Worksheet					
Conductors and Cables	98685.00	18840.00	17302.50	30495.00	32047.50
Service Connections	93780.00	22230.00	21322.50	29175.00	21052.50
#REF!	0.00				
#REF!	0.00				
Poles and associated equipment	40395.00	9041.25	9611.25	10708.75	11033.75

Conductors and Cables

SUMMARY	All Zones	tr02	tr01	tr03	tr00
Connections	302	83	77	81	61
Total Material	182987.55	34361.95	31196.23	55150.69	62278.68
Total Labour (Rands)	98685.00	18840.00	17302.50	30495.00	32047.50

DETAIL

Description	**Material Cost (R / Unit)**	**Labour Cost (Points)**	All Zones 302	tr02 83	tr01 77	tr03 81	tr00 61
35mm sq. Bare Neutral ABC	15.68	0.03	11241	2099	1898	3359	3885
70mm sq. Bare Neutral ABC	31.62	0.06	0	0	0	0	0
Cond Squirrel 3ph	3.51	0.03	1917	413	409	707	388

Service Connections

SUMMARY	All Zones	tr02	tr01	tr03	tr00
Connections	302	83	77	81	61
Total Material	128903.40	31330.26	29874.03	39222.96	28476.15
Total Labour (Rands)	93780.00	22230.00	21322.50	29175.00	21052.50

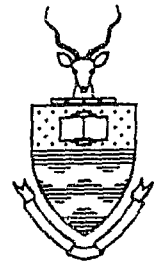
DETAIL

Description	Material Cost (R / Unit)	Labour Cost (Points)	CIP Code	Transformer Z Connections	All Zones 302	tr02 83	tr01 77	tr03 81	tr00 61
	19.60	0.00	0360####A###		302	83	77	81	61
	48.26	0.00	3171###1##A#		302	83	77	81	61
Airdac 10mm Concentric	11.19	0.03	KKE20###CA####B		0	0	0	0	0
Airdac 4mm Concentric	8.67	0.03	KKE24###CA####B		12504	2964	2843	3890	2807

Poles etc.

SUMMARY	All Zones	tr02	tr01	tr03	tr00
Connections	302	83	77	81	61
Total Material	108968.77	28101.03	26091.39	27341.94	27434.41
Total Labour (Rands)	40395.00	9041.25	9611.25	10708.75	11033.75

CAD Code	CIP Code	Material Cost (Rands/Unit)	Labour Cost (Points)	All Zones	tr02	tr01	tr03	tr00
				0	83	77	81	61
0050WB	WT1#####C#####A	2.07	0.25	146	24	30	44	48
0055WD	WT1#####E#####A	533.23	0.25	5	5	0	0	0
0053WG	WT1#####O#####A	502.58	0.25	4	1	1	1	1
1700W#CQ#G#	WTE3AQC####G##	258.93	0.75	5	5	0	0	0
1265#	WT2AAA###1####B	232.34	0.21	4	1	1	1	1
1704WBQQ#PA	WTF3FQQ###BP#A	1,249.49	2.25	0	0	0	0	0
1705W#HQ#AA	WTF3GQH####A#A	1,157.36	1.50	0	0	0	0	0
1706W#HQ#A#	WTF3IQH####A##B	571.41	0.75	4	1	1	1	1
1800WBHPQAD	WCF3APHQ##BA#D	497.77	1.20	0	0	0	0	0
1100W##1#A#	WTA4A1#####A##B	107.43	0.20	90	16	13	27	34
1121W##1#B#	WTA4C1#####B##B	193.95	0.25	19	4	5	7	3
1266#	WT3AAA###1####B	137.70	0.53	70	14	22	18	16
1122W##1#B#	WTA4D1#####B##B	212.58	0.25	16	2	5	5	4
1120W##1#B#	WTA4E1#####B##B	134.93	0.25	31	8	9	6	8
1142W##1#BC	WTA4G1#####B#CB	198.62	0.35	12	2	5	2	3
1143W##1#BC	WTA4I1#####B#CB	434.92	0.25	3	1	0	1	1
3055#F#1A###C	WKWA1AAF##A###C	31.87	0.09	151	29	30	44	48
1860CDK3F1##A	WKTACDK3F1#B#A	15,100.75	6.28	4	1	1	1	1



DXF-MAP

User Reference Manual

Technical Product

Version 1.00

Document Status: Approved

Table of Contents

Table of Contents ii

Change History iv

Configuration Control iv

Document History iv

Revision History iv

Management Authorisation iv

Change Forecast iv

1 Scope 1

1.1 Introduction 1

1.2 Purpose 1

1.3 Applicability 1

1.4 Definitions 1

1.5 Audience 1

1.6 Applicable Documents 2

1.7 Assumptions 2

1.8 Requirements Traceability 2

2 Introduction 3

2.1 Background 3

2.2 Hardware Requirements 3

2.3 Getting Started in CAD 3

2.4 Application Window 6

3 File 7

3.1 Open 7

3.2 Save As (Only activated by condition described in 3.1.3) 8

3.3 Exit 8

Change History

Configuration Control

Project:	DXF-MAP
Title:	User Reference Manual
Doc. Reference:	D:\1996_34\TP\DXF_MAP\DOCS\TB210.001.DOC
Created by:	T Rajakanthan
Creation Date:	96/08/18

Document History

Version	Date	Status	Who	Saved as:
0.01	96/08/18	Draft	T R	TB210.001
1.00	96/08/25	Approved	T R	TB210.100

Revision History

Version	Date	Changes
0.01	96/08/18	Created document using QST32430.100
1.00	96/08/25	The document was approved
1.00	96/10/03	The URM was updated to reflect the latest changes made to the program
1.00	96/10/10	The URM was further updated to describe the setup required in the CAS package before the conversion can be done.

Management Authorisation

Version	Date	Status	Management Board Minute Reference
1.00	96/08/25	Approved	TB 008

Change Forecast

The user reference manual will change to reflect any modifications made to the coding due implementation complications

1 Scope

1.1 Introduction

The DXF to MAP file converter program converts AutoCAD drawing exchange files to MAP format so that it can be used in the test bed. The program itself is very easy to use but the drawing in the AutoCAD environment has to be done using the specified methodology so that the conversion can be done.

1.2 Purpose

This document serves as a User Reference Manual for the DXF to MAP file converter

1.3 Applicability

This document is applicable to the DXF to MAP mini-project

1.4 Definitions

URM: User Reference Manual

SEAL: Software Engineering Applications Laboratory

1.5 Audience

- The manager for this project, namely Mr A Meyer
- The software co-ordinator, namely Dr B Dwolatzky
- The developer on this project, namely T Rajakanthan
- Individuals who perform 2nd and 3rd party surveillance on SEAL QMS.
- Full-time members of SEAL Management Board.

1.6 Applicable Documents

1.6.1 Specifications

1.6.2 Standards

a. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 0.01, 1 April 1994

1.6.3 Procedures

1.6.4 Guidelines

9An example of the use of this template may be found in TMP 121.100 (Task Management Package, SEAL Project 1995_34))

1.6.5 Other Documents

1.7 Assumptions

It is assumed that the user is familiar with the use of Windows 3.1 or higher and navigating with the use of a mouse. The user must also be familiar and have access to some form of CAD package.

This program will only be of concern to technical people and therefore the standard of this URM will be accordingly set.

1.8 Requirements Traceability

ISO 9001(1994) 4.4 Design Control

2 Introduction

2.1 Background

This section provides additional information regarding the origin and application of the product.

2.2 Hardware Requirements

2.2.1 Listing of minimum hardware required to run the product.

- 486 - DX33 IBM compatible or better
- 4MB of RAM or more

2.2.2 Listing of minimum software required to run the product.

- Windows© '95 is a must as this is a 32-bit application.
- Some form of professional CAD package is required. An example of this would be Microstation© '95 or AutoCAD© 13. The CAD package must be one of the later versions as the DXF format was based on AutoCAD© 11.

2.3 Getting Started in CAD

2.3.1 Setting up the CAD package

Before the drawing can be done, it is important to set up the CAD package environment. A proper setup will ensure that the drawing is done correctly. Please refer to the manuals of the CAD package that you are using to ensure that the following instructions are implemented correctly. Failure to do so may result in the conversion program not being able to function correctly.

1. If an existing map layout of a township is going to be traced over, it is first essential to isolate layers of the drawing that are not in use. Seven layers are required for full drawings to be done.
2. These layers must be named using the following names and must all be in uppercase.
   - WORKSPACE
   - TOWNSHIP

- STAND
- ROAD
- COSTREGION
- STANDNAME
- ROADNAME
- COSTNUMBER

3. The layer names assigned must be saved to a file. The next time the CAD package is used you may have to attach this file in order to restore the layer name scheme used before.

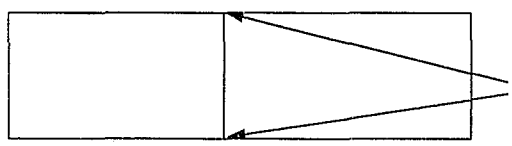
4. A block must be placed around the working area on the drawing on the TOWNSHIP layer. The starting co-ordinates must be place using precision input at 0,0. The opposite end must be placed in the first quadrant so that all the co-ordinates are positive. If the co-ordinates (0,0) happens to be in the middle of the drawing then move the drawing so that it is within the block, just drawn on the layer TOWNSHIP. This will ensure that all the co-ordinates are positive and measured distances are with respect to the origin.

5. Before proceeding with any more drawings it is recommended that the layer lock is activated. This will ensure that no drawings are accidentally done on the wrong layer. It will also prevent the accidental manipulation of elements on other layers

Once all these steps are completed drawing can begin.

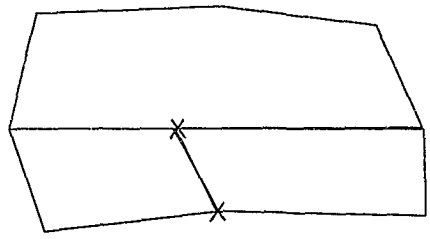
2.3.2 Drawing various elements

Select the polygon drawing mode and make sure your are on the correct layer eg. STAND, ROAD or COSTREGION. If you are tracing over a drawing, use tentative points to locate vertices, accurately. Use polygons to represent each stands, roads and cost regions. The polygon vertices must overlap as shown in the drawing below.



The same applies to road and cost regions.

Note:- The cost regions must fill the entire block defining the TOWNSHIP. Furthermore all the vertices of adjoining polygons must overlap. See the following diagram.



Even if one side of the polygon is a straight line vertices must be placed wherever there is going to be an adjoining polygon.

Note:- The polygons constituting the cost regions must be convex. In other words one should be able to draw a line from any vertex to any other vertex without going out of the region defined by the polygon.

2.3.3 Labelling polygons (identifiers)

All the stands, roads and cost regions must be labelled. The program uses an algorithm whereas the shortest distance between the polygon and the label is calculated. It is important for this reason that you position the label approximately at the **centroid** of the polygon. Failure to do this may result in adjoining polygons having the same label after the conversion process. It is also necessary not to have spaces between the names.

The cost factor must be written after the words "COST=" (without the inverted commas. For example "COST=23". Case does not matter.

Once again please make sure you are on the correct layer before you begin labelling.

Please make sure you are on the correct layer before you start labelling. Eg STANDNAME, ROADNAME or COSTNUMBER.

Note:- It is not necessary to have all the layers named and used. You must however have a TOWNSHIP defined. You can have one or any combinations of the following.

- stands and stand names
- road and road names

- cost regions and cost numbers.

2.3.4 Exporting as a DXF file

Once the drawing is complete then the file can be exported as a DXF file. Please ensure the export options of your CAD package are set correctly, so that all the shapes are exported as polygons and **not** as polyface mesh.

The layer names of the exported file do not automatically correspond with those in the working environment. You must make sure that the layer names of the exported file DO correspond to those in the working environment.

Once the DXF file has been successfully exported, the conversion program can be run.

2.4 Application Window

2.4.1 The application is similar in appearance to any other standard windows based program. It is entirely menu driven and is designed as such that the user cannot make any mistakes. The following sections will guide you through its use.

3 File

3.1 Open

3.1.1 Function

The function of this option is to activate the open-dialogue box from which you can select a file to be opened.

3.1.2 How to use this feature

You can use the mouse to change directories until you get to the directory of your choice. Click on the file that you wish to open. Alternatively, you can use the *tab* key to navigate about the dialogue box.

3.1.3 Remarks

This dialogue box will only allow you to open DXF files. If you open a valid DXF file, it will activate the Save-as-dialogue box and prompt you for filename to save the data that is to be converted. Otherwise an appropriate error message will be displayed. In either case, the name and path of the opened file will be displayed in the client area of the application window.

3.1.4 Error Messages

There are two possible error messages that you will receive when you open an invalid file.

- An error message is generated, if the file you opened is not a DXF file, but a text file with a DXF extension. It is either this reason or the DXF file is corrupted. If either of this is the case then the message "The file you have opened is invalid!" will be displayed. Press OK to continue.

- If the file you opened is a DXF file but there are certain discrepancies in the file content. These discrepancies are:

  1. There is no TOWNSHIP defined or there are more than one TOWNSHIP

  2. The number of stands does not equal the number of stand names.

  3. The number of roads does not equal the number of road names.

4. The number of cost regions does not equal the number of cost numbers.

5. If any of these quantities are reported as zero then its because there are none of these elements or they have been drawn on the wrong layer.

This information can be used to debug the DXF file drawing before the conversion is performed.

3.1.5 Requirements Traceability

3.2 Save As (Only activated by condition described in 3.1.3)

3.2.1 Function

The function of this option is to activate the save-as-dialogue box where you can specify the MAP file name to which you would like the converted data to be saved.

3.2.2 How to use this feature

You can use the mouse to change directories until you get to the directory of your choice. If you want to overwrite a file then select that file. Otherwise, type in the name of the file you wish to save to.

Instead of the mouse, you can use the *tab* key to navigate about the dialogue box.

3.2.3 Remarks

This dialogue box will only allow you to save MAP files. When you click on *save* the program will execute the conversion. When the conversion is completed a message will be displayed to reflect this status.

3.2.4 Error Messages

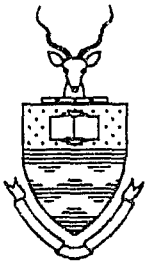
There are no error messages associated with this operation.

3.2.5 Requirements Traceability

3.3 Exit

3.3.1 Function

Unconditionally exits the program



DXF-MAP

Software High Level Design

Management Product

Revision 1.00

Document Status: Approved

Table of Contents

Table of Contents ii

Change History iv

Configuration Control iv

Document History iv

Revision History iv

Management Authorisation iv

Change Forecast iv

1 Scope 1

1.1 Introduction 1

1.2 Applicability 1

1.3 Definitions 1

1.4 Audience 1

1.5 Applicable Documents 1

1.6 Assumptions 2

1.7 Requirements Traceability 2

2 List of modules 3

3 Module 1: TRA00201 4

3.1 Purpose 4

3.2 Module diagram 4

3.3 Module interface 4

3.4 Comments 4

3.5 Submodule 1.1: Class Coordinates 4

3.6 Submodule 1.2: Class CoordList 5

3.7 Submodule 1.3: Class ListNumber 6
3.8 Submodule 1.4: Class OutputFile 7
4 Module 2: TRA00401 8
4.1 Purpose 8
4.2 Module diagram 8
4.3 Module interface 8
4.4 Submodule 1.1: Class TCommDlgWnd 8
5 Formal architecture: Class Diagram 10

Change History

Configuration Control

Project:	DXF-MAP
Title:	Software High Level Design
Doc. Reference:	D:\1996_34\TP\DXF_MAP\DOCS\TB230.001.DOC
Created By	T Rajakanthan
Creation Date:	96/09/21

Document History

Version	Date	Status	Who	Saved as:
0.01	96/09/21	Draft	T R	TB230.001
1.00	96/10/14	Approved	T R	TB230.100

Revision History

Version	Date	Changes
0.01	96/09/21	New document created using QST32440.100
1.00	96/10/14	The document was approved

Management Authorisation

Version	Date	Status	Management Board Minute Reference
1.00	96/10/14	Approved	TB 010

Change Forecast

This document will be updated each time new design requirements are identified.

1 Scope

1.1 Introduction

The purpose of this document is to discuss the high level design of this conversion program.

1.2 Applicability

This document serves as the starting point of the translation of the problem specification into actual software.

1.3 Definitions

D - Data

E - Event

1.4 Audience

- The Product Manager, namely Dr B Dwolatzky
- The Customer or Client
- The Product Developers, namely T Rajakanthan
- Individuals who perform 2nd and 3rd party surveillance on SEAL QMS.
- Fulltime members of SEAL Management Board.

1.5 Applicable Documents

1.5.1 Standards

a. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 1.00, 3 October 1994

1.5.2 Procedures

1.5.3 Guidelines

1.5.4 Exemplar Documents

An example of this use of this template can be found in:

a) TMP 126 Task Management Package High Level Design, Revision 1.0.2, 12 December 1995 (See project 1995_34).

1.6 Assumptions

It is assumed that the user is familiar with the Booch Notation as designed by Grady Booch.

1.7 Requirements Traceability

2 List of modules

Table 2.1: List of all modules in the application

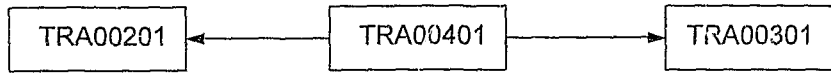
Module No.	Module Name	Description
1.	TRA00201	Classes and methods associated with storing records in a linked list. This is broken up into two files; one for the headed and the other for the cpp file.
2.	TRA00401	Class containing the search and match algorithm. This class also support the windows interface.
3.	TRA00301	This contains the windows interface related resources.
4.	defs.h	This is the OWL defs supplied with the Borland 5.
5.	TRA00301.rh	This is a resource header file that is associated with TRA 00301. This name could not be changed to conform to section of 3.1.3. of TB 006, the Configuration Management Plan. This file is created by TRA00301.rc

3 Module 1: TRA00201

3.1 Purpose

This module is responsible for creating records and maintaining a linked list. It also features a class which handles external file writing.

3.2 Module diagram



3.3 Module interface

Table 3.1: A description of all inputs to and outputs from the module

Module 1: TRA00201					
Input			Output		
Label	Nature	Source	Nature	Destination	Label
co-ordinates	2 x float	passed by TRA00401 during the search and extract data algorithm	2 x float	passed back to TRA00401 during the search and polygon to identifier matching algorithm.	co-ordinates
identifier	text string	passed by TRA00401 during the search and extract data algorithm	text string	passed back to TRA00401 during the search and polygon to identifier matching algorithm.	identifier

3.4 Comments

3.5 Submodule 1.1: Class Coordinates

3.5.1 Purpose

This class is responsible for containing two floats to make up an *xy* co-ordinate.

3.5.2 Class diagram



3.5.3 Class interface

Table 3.2: A description of all inputs to and outputs from the Class

Submodule 1.1: Class Coordinates					
Input			Output		
Label	Nature	Source	Nature	Destination	Label
co-ordinates	2 x float	passed by class CoordList	2 x float	returned to class CoordList	co-ordinates

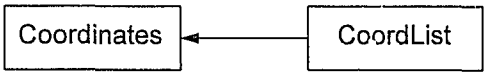
3.5.4 Comments

3.6 Submodule 1.2: Class CoordList

3.6.1 Purpose

This class is responsible for administrating a linked list of objects of Coordinates.

3.6.2 Module diagram



3.6.3 Class interface

Table 3.3: A description of all inputs to and outputs from the class

Submodule 1.2 Class CoordList					
Input			Output		
Label	Nature	Source	Nature	Destination	Label
co-	2 x	passed by TRA00401	2 x	passed back to	co-

Submodule 1.2 Class CoordList					
Input			Output		
Label	Nature	Source	Nature	Destination	Label
ordinates	float	during the search and extract data algorithm	float	TRA00401 during the search and polygon to identifier matching algorithm.	ordinates

3.6.4 Comments

3.7 Submodule 1.3: Class ListNumber

3.7.1 Purpose

This class is responsible for containing a set of co-ordinates and the identifier located at this co-ordinate.

3.7.2 Module diagram

This is a stand alone unit used by module TRA00401

3.7.3 Class interface

Table 3.4: A description of all inputs to and outputs from the class

Submodule 1.2 Class ListNumber					
Input			Output		
Label	Nature	Source	Nature	Destination	Label
co-ordinates	2 x float	passed by TRA00401 during the search and extract data algorithm	2 x float	passed back to TRA00401 during the search and polygon to identifier matching algorithm.	co-ordinates
identifier	text string	passed by TRA00401 during the search and extract data algorithm	text string	passed back to TRA00401 during the search and polygon to identifier matching algorithm.	identifier

3.7.4 Comments

3.8 Submodule 1.4: Class OutputFile

3.8.1 Purpose

This class is responsible for writing test and numbers to an output file.

3.8.2 Module diagram

This class is stand alone and it is used directly by class TRA00401

3.8.3 Class interface

Table 3.5: A description of all inputs to and outputs from the class

Submodule 1.4 Class OutputFile					
Input			Output		
Label	Nature	Source	Nature	Destination	Label
Filename	string	passed by TRA00401 during the writing to file stage	file	outputs to file with the given name	
co-ordinates	2 x float	passed by TRA00401 during the writing to file stage	2 x float	Written to file	co-ordinates
identifier	string	passed by TRA00401 during the writing to file stage	identifier	Written to file	identifier

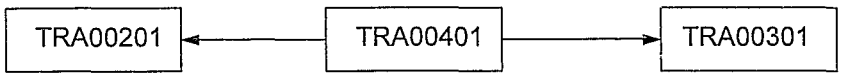
3.8.4 Comments

4 Module 2: TRA00401

4.1 Purpose

This module is responsible for creating not only the 'search and extract data' and 'polygon to identifier matching' algorithms but also for the windows related interfaces.

4.2 Module diagram



4.3 Module interface

Table 4.1: A description of all inputs to and outputs from the module

Module 1: TRA00401					
Input			Output		
Label	Nature	Source	Nature	Destination	Label
DXF file	text file	read by TRA00401 during the search and extract data algorithm	text file	written to classes after polygon to identifier matching is complete.	Co-ordinates
filename	text string	passed to TRA00401 to indicate the file that has to be opened			
filename	text string	passed to TRA00401 to indicate the filename that has to save the file			

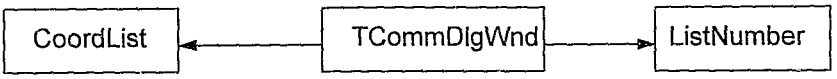
4.3.1 Comments

4.4 Submodule 1.1: Class TCommDlgWnd

4.4.1 Purpose

Class responsible for the search and match algorithms. This class also supports the windows interface.

4.4.2 Class diagram



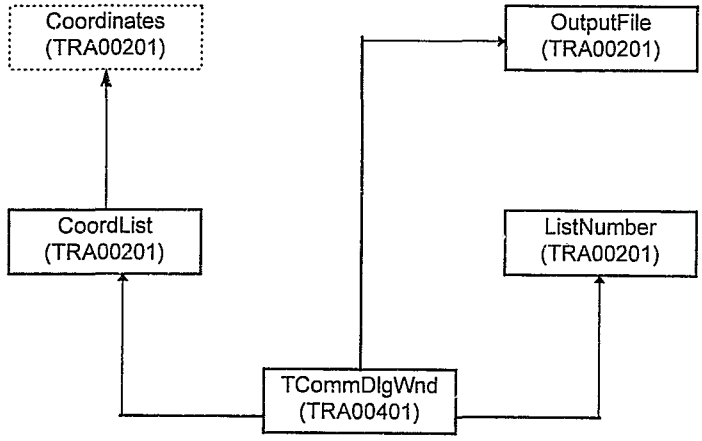
4.4.3 Class interface

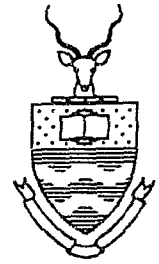
Table 3.2: A description of all inputs to and outputs from the Class

Submodule 1.1: Class TCommDlgWnd					
Input			Output		
Label	Nature	Source	Nature	Destination	Label
DXF file	text file	read by TRA00401 during the search and extract data algorithm	text file	written to classes after polygon to identifier matching is complete.	Co-ordinates
filename	text string	passed to TRA00401 to indicate the file that has to be opened			
filename	text string	passed to TRA00401 to indicate the filename that has to save the file			

4.4.4 Comments

5 Formal architecture: Class Diagram





DXF-MAP

Software Low Level Design

Management Product

Revision 1.00

Document Status: Approved

Table of Contents

Table of Contents ii

Change History iv

Configuration Control iv

Document History iv

Revision History iv

Management Authorisation iv

Change Forecast iv

1 Scope 1

1.1 Introduction 1

1.2 Purpose 1

1.3 Applicability 1

1.4 Definitions 1

1.5 Audience 1

1.6 Applicable Documents 1

1.7 Assumptions 2

1.8 Requirements Traceability 2

2 Module 1.1: Class Coordinates 3

2.1 Description of module 3

2.2 Modular Functionality 3

2.3 Algorithms 3

3 Module 1.2. Class CoordList 4

3.1 Description of module 4

3.2 Modular Functionality 4

3.3 Algorithms 4

4 Module 1.3: Class ListNumber 5

4.1 Description of module 5

4.2 Modular Functionality 5

4.3 Algorithms 5

5 Module 1.4: Class OutputFile 6

5.1 Description of module 6

5.2 Modular Functionality 6

5.3 Algorithms 6

6 Module 2.1: Class TCommDlgWnd 7

6.1 Description of module 7

6.2 Modular Functionality 8

6.3 Algorithms 9

Change History

Configuration Control

Project:	DXF-MAP
Title:	Software Low Level design
Doc. Reference:	D:\1996_34\TP\DXF_MAP\DOCS\TB240.001.DOC
Created by:	T Rajakanthan
Creation Date:	96/09/23

Document History

Version	Date	Status	Who	Saved as:
0.01	96/09/26	Draft	T R	TB240.001

Revision History

Version	Date	Changes
0.01	96/09/26	New document created using QST32450.100

Management Authorisation

Version	Date	Status	Management Board Minute Reference

Change Forecast

Changes will be mad if there are problems encountered in the coding.

Change History

Configuration Control

Project:	DXF-MAP
Title:	Software Low Level design
Doc. Reference:	D:\1996_34\TP\DXF_MAP\DOCS\TB240.001.DOC
Created by:	T Rajakanthan
Creation Date:	96/09/23

Document History

Version	Date	Status	Who	Saved as:
0.01	96/09/26	Draft	T R	TB240.001

Revision History

Version	Date	Changes
0.01	96/09/26	New document created using QST32450.100

Management Authorisation

Version	Date	Status	Management Board Minute Reference

Change Forecast

Changes will be mad if there are problems encountered in the coding.

1 Scope

1.1 Introduction

This document will discuss the low level design of the various classes and algorithms

1.2 Purpose

The aim of this document is to allow another designer to maintain the code.

1.3 Applicability

This document has to be used in conjunction with TB 220, URM and TB230, High level software design

1.4 Definitions

URM - User Reference Manual

1.5 Audience

- The Product Manager, namely Dr Dwolatzky
- The Product Developer, namely T Rajakanthan
- Individuals who perform 2nd and 3rd party surveillance on SEAL QMS.
- Fulltime members of SEAL Management Board.
- Future member of SEAL who may have to carry out maintenance on this program.

1.6 Applicable Documents

1.6.1 Specifications

Specified in TB 200, Mini-project functional specifications.

1.6.2 Standards

a. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 1.00, 3 October 1994

1.6.3 Procedures

Boillot M. H., Gleason G. M, Horn L. W., Essentials of Flowcharting, 3rd Edition, Wm. C. Brown Company Publishers, 1982

1.6.4 Guidelines

1.6.5 Exemplar Document

A helpful example where this template is used can be found in:

a) TMP 127 Task Management Package Low Level Design, Revision 1.00, 27 December 1995. (See project 1995_34)

1.7 Assumptions

It is assumed that the reader is familiar with computer programming.

1.8 Requirements Traceability

2 Module 1.1: Class Coordinates

2.1 Description of module

This is a general class for containing two floats, namely *xy* co-ordinates. It has methods for returning these co-ordinates. It also has pointers which will allow it to be made into a linked list.

2.2 Modular Functionality

N/A

2.3 Algorithms

None

3 Module 1.2. Class CoordList

3.1 Description of module

This class can support a linked list of Co-ordinates. It is responsible for passing information to and extracting information from the linked list.

3.2 Modular Functionality

N/A

3.3 Algorithms

None

4 Module 1.3: Class ListNumber

4.1 Description of module

This class accommodates a single *xy* Co-ordinate and an text string representing the identifier.

4.2 Modular Functionality

N/A

4.3 Algorithms

None

5 Module 1.4: Class OutputFile

5.1 Description of module

This class is responsible for writing a text string or formatted numbers (float) to a text file.

5.2 Modular Functionality

N/A

5.3 Algorithms

None

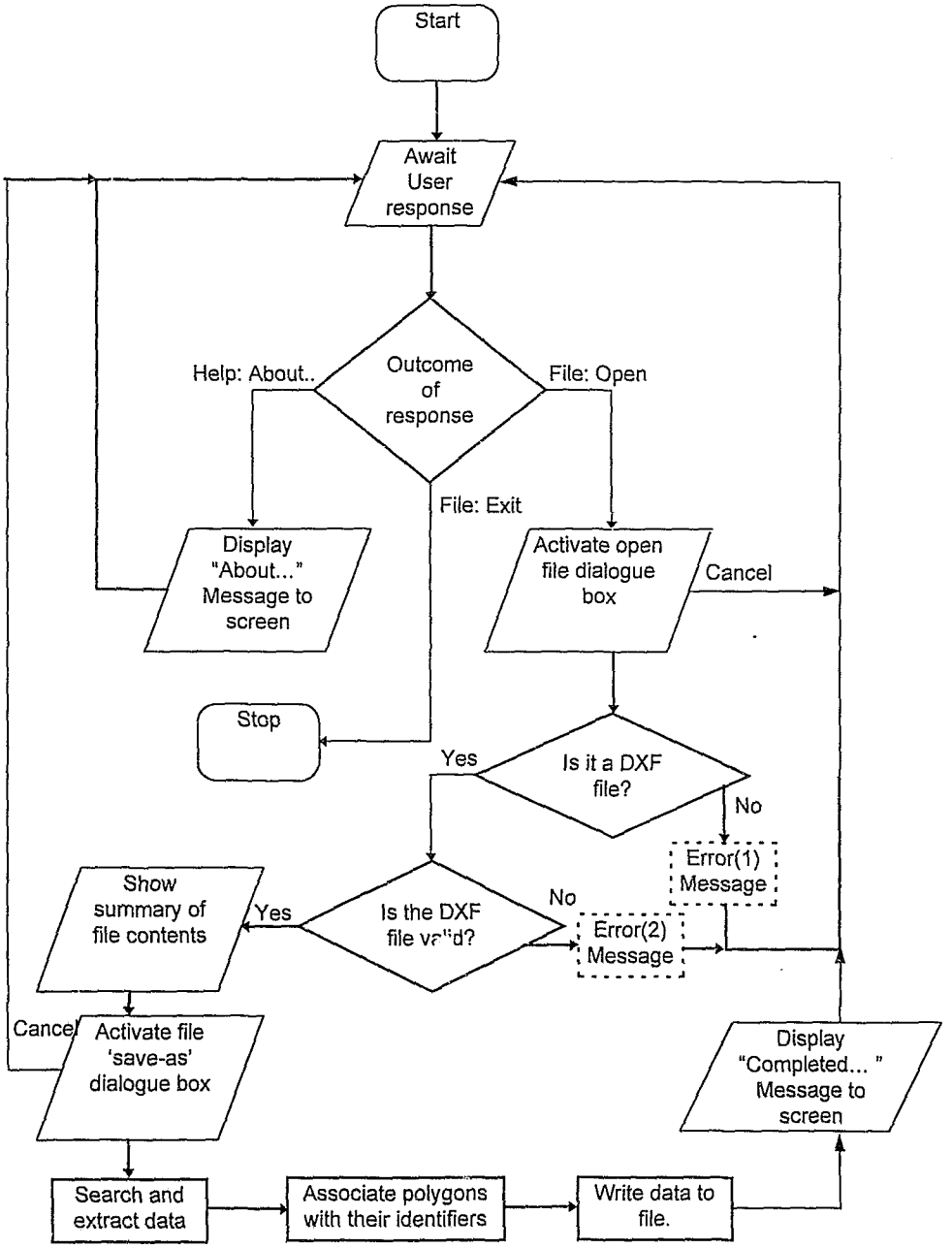
6 Module 2.1: Class TCommDlgWnd

6.1 Description of module

This class is not responsible for the following:

- Windows interfaces, dialogue boxes for opening and saving files etc.
- Check algorithm for identifying the validity of an opened DXF file.
- Extracting the relevant data from a valid DXF file - search and data extract algorithm.
- Associating polygons with its identifiers - polygon to identifier associating algorithm.

6.2 Modular Functionality



6.3 Algorithms

The DXF file is a text file and every entry is on a new line. There are indicators to show the type data that will follow on the consecutive line.

6.3.1 Algorithm 1: Check if the opened file *is* a DXF file

All DXF files have a section called ENTITIES. This part of the code will check consecutive lines for the word ENTITIES to determine whether it *is* a DXF file or not. It will search through a fixed number of lines (eg. 50000, which can be changed) for the word ENTITIES. If it found then the program will proceed to the next stage otherwise the file is declared invalid. The error(1) message is displayed.

6.3.2 Algorithm 2: Check if the *information* in the DXF file is valid

This algorithm checks the various levels on the DXF file for the following information; namely territory, stands, roads, cost regions, stand names, road names and cost numbers. This is done by the following method:

1. Open the specified file, start at the top of the file and search for the word ENTITIES.
2. Once the word in found look for the word POLYLINE.
3. Every time POLYLINE is found, identify the layer it is on and note if it is on any one of the significant layer. These significant layers are layers are TERRITORY, STAND, ROAD and COSTREGION. Counters will be used to keep track of quantities.
4. As soon as the a significant layer has been identified, no more identification must be done until the next word POLYLINE is encountered. The reason for this being that the layer is repeated for every vertex of a polygon.
5. Stop the search when the word ENDSEC is encountered.
6. Start at the top of the file and search for the word ENTITIES, again.
7. Once the word in found look for the word TEXT.
8. Every time TEXT is found identify the layer it is on and note if it is on any one of the significant layer. These significant layers are layers are

STANDNAME, ROADNAME and COSTNUMBER. Counters will be used to keep track of these quantities.

9. The search will stop when the word ENDSEC is read to indicate end of section

10. The number of STANDs and STANDNAMEs are compared. The number of ROADs and ROADNAMEs are compared. The number of COSTREGIONs and COSTNUMBERs are compared. The number of TERRITORYs must be equal to 1. Any inequality will imply that the program cannot continue and a corresponding error(2) message will be displayed. Otherwise a status message showing a summary of file contents will be displayed.

6.3.3 Algorithm 3: Search and Extract Data

1. Dynamically create arrays for holding the co-ordinates of polygons. The size of the arrays will be set from the counters used in the previous routine.

2. Open the specified file, start at the top of the file and search for the word ENTITIES.

3. Once the word in found look for the word POLYLINE.

4. Every time POLYLINE is found, identify the layer it is on. If it is on the layer TERRITORY then proceed

5. Look for VERTEX.

6. Once VERTEX is found look for the number 10. Read the number on the consecutive line. This will be the *x* co-ordinate.

7. This will be immediately followed by the number 20 and then the *y* co-ordinate.

8. Pass the extracted co-ordinates of the vertex to the object.

9. Repeat steps 5 to 8 until the word SEQEND is encountered. This will imply that all the vertices have been identified.

10. These steps will stop when ENDSEC is encountered.

These steps are for extracting the co-ordinates of the vertices of the polygon TERRITORY. The algorithm for extracting similar data for stands roads and cost regions are slightly different and is described below (in the context of stands).

11. Start at the top of the file and search for the word ENTITIES.

12. Once the word in found look for the word POLYLINE.

13. Every time POLYLINE is found, identify the layer it is on. If it is on the layer STAND then proceed.

14. Look for VERTEX.

15. Once VERTEX is found look for the number 10. Read the number on the consecutive line. This will be the *x* co-ordinate.

16. This will be immediately followed by the number 20 and then the *y* co-ordinate.

17. Pass the extracted co-ordinates of the vertex to the object. But now there are an array of these object. The vertices of a polygon must be passed to the correct object in the array. A counter will be used to indicate the number of the object (polygon).

18. Repeat steps 13 to 17 until the word SEQEND is encountered. This will imply that all the vertices have been identified. The object counter will be incremented so that the next set of vertices of the polygon will be placed in another object.

19. These steps will stop when ENDSEC is encountered.

These steps are repeated for roads and cost regions. Once all the co-ordinates have been extracted and stored in objects, their identifiers its co-ordinates have to be obtained. The algorithm is described in the context of stand names.

20. Start at the top of the file and search for the word ENTITIES.

21. Once the word in found look for the word STANDNAME.

22. Every time STANDNAME is found skip and read the 8th line of the DXF file. This will be the *x* co-ordinate.

23. This will be immediately followed by the number 20 and then the *y* co-ordinate.

24. Skip and read the 4th line of the DXF file. This will be the polygon identifier.

25. Pass the identifier and its extracted co-ordinates to the object. These are an array of object. The data must be passed to the correct object in

the array. A counter will be used to indicate the number of the object and will be incremented every time set of data is passed.

26. Repeat steps 21 to 25 until the word ENDSEC is encountered.

6.3.4 Algorithm 4: Associate Polygons with their Identifiers

This algorithm forms an association between polygons and their respective identifiers. This is done using the following steps, in the context of associating stands with stand names. (Remember: there will be two arrays, one with the polygons and the other with the identifiers

1. For each stand, the sum the square of the difference between the identifier and the vertex co-ordinates are calculated.

2. This sum is divided by the number of vertices to give an average number.

3. The average number is compared with the previous average number calculated for the previous identifier. If the new average is smaller then the location of this identifier in the array is passed to the stand object. If the identifier is the first, there will be no averages before to compare with and hence an arbitrarily large number will used to compare with.

4. Steps 1 to 3 are repeated until all the identifiers have been checked. At the end of this routine the identifier located approximately at the centre of the polygon will have the smallest sum.

5. These procedures are then repeated for every single stand.

6.3.5 Algorithm 5: Write Data to File

The algorithm described below is similar for all cases but is discussed in the context of stands.

1. For each stand write the STAND to the output file

2. The reference number is retrieved from the stand object and used to access the corresponding stand name co-ordinates in the array containing identifier information. These co-ordinates are written to the output file.

3. Similarly the reference number is retrieved from the stand object again and used to access the corresponding identifier in the array containing identifier information. This identifier is then written to the output file.

4. All the co-ordinates of all the vertices are then written.

5. The co-ordinates of the first vertex is repeated.
6. Steps 1 to 5 are repeated for all the stands.

Project Title

Intelligent Maps

Abstract

The software modules developed for this project form part of a complete package that will be used for the automated design and optimisation of electrical distribution networks. In order for the design software to operate on the input CAD file, an "intelligent map" must first be created so that the significance of various features on the map are known. The intelligent map is a "cleaned up" CAD drawing linked to a non-graphical data file. This project is concerned with the conversion from the input (standard DXF AutoCAD file format) into lists of data that are processed by further software modules. Since the map is likely to contain errors, it is cleaned up through the elimination of duplicate (identical) lines and multiple vertices (due to inaccuracies such as line under and overshoots). Further processing involves the segmentation of lines into lines the form individual stand boundaries. The next modules involve the recognition of map features: the township and stand boundaries. Finally, the corrected data is converted into DXF format for display and inspection. The intelligent map creation procedure is implemented in the C++ programming language.

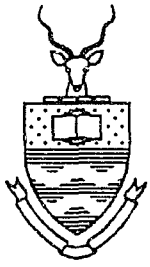
References

The work contribution was done by the following 4th year (honours level - 1997) students:-

Lewis T, Design No. 25P/97.

Strelec GJ, Design No. 51P/97.

Supervisor: Meyer
Department of Electrical Engineering
University of the Witwatersrand
Private Bag x3
P. O. WITS
2050



SADDIN

Master Document List

Management Product

Version 1.00

Document Status: Approved

Table of Contents

Table of Contents ii

Change History iii

Configuration Control iii

Document History iii

Revision History iii

Management Authorisation v

Change Forecast v

1 Scope 1

1.1 Introduction 1

1.2 Purpose 1

1.3 Applicability 1

1.4 Definitions 1

1.5 Audience 1

1.6 Applicable Documents 2

1.7 Assumptions 2

1.8 Requirements Traceability 2

1.9 Procedures 2

2 Master Document List 5

Change History

Configuration Control

Project:	SADDIN
Title:	Master Document List
Doc. Reference:	D:\1996_34\MP\TB001.100
Created by:	T Rajakanthan
Creation Date:	25 June 1996

Document History

Version	Date	Status	Who	Saved as:
0.01	96/04/29	Draft	T R	TB001.001
1.00	96/06/24	Approved	T R	TB001.100

Revision History

Version	Date	Changes
0.01	96/04/29	New document created from template QST00110.104
0.01	96/04/29	Creation of Document TB002.001 was recorded
0.01	96/05/03	Creation of Document TB003.001 was recorded
0.01	96/05/05	Existence of minutes TB 501.001, TB 502.001 and TB 503.001 was recorded
0.01	96/05/13	Creation of Document TB004.001 was recorded
0.01	96/05/16	Creation of Document TB005.001 was recorded
0.01	96/05/17	Creation of Document TB006.001 was recorded
0.01	96/05/24	Creation of minutes TB 504.001 was recorded
0.01	96/06/07	Creation of minutes TB 505.001 was recorded
0.01	96/06/22	Creation of Document TB102.001 and the existence of document TB101.100 was recorded
1.00	96/06/24	Document approval was recorded
1.00	96/08/12	The project initiation audit was recorded
1.00	96/08/15	The creation of DXF-MAP project functional specification document was recorded TB 200
1.00	96/08/18	The creation of DXF-MAP project functional user reference

		manual was recorded TB 210
1.00	96/08/21	The creation of DXF-MAP product verification and validation document was recorded TB 280
1.00	96/10/14	The approval of minutes meeting TB508and the version of the documents it implicates was updated
1.00	96/09/22	The creation of DXF-MAP High level design document was recorded TB 230
1.00	96/09/27	The creation of DXF-MAP low level design document was recorded TB 240
1.00	96/10/01	The creation of DXF-MAP code description document was recorded TB 250
1.00	96/10/14	The approval of minutes meeting TB 509 and TB 510 and the version of the documents it implicates was updated
1.00	96/10/15	Dates of the latest versions were recorded
1.00	96/10/17	Errors arising from the previous audit were corrected
1.00	96/11/12	Creation of Document TB 150 was recorded
1.00	96/12/23	Dates of updated documents were recorded
1.00	97/01/13	Dates of updated documents were recorded
1.00	97/01/15	Dates of updated documents were recorded
1.00	97/01/28	IP TB 3002 audit was approved.
1.00	97/01/31	Creation of TB 301 was recorded
1.00	97/03/03	Updates in Document version TB 302
1.00	97/03/25	All the latest revision information was captured
1.00	97/04/08	Creation of Technical product TB 304 was recorded.
1.00	97/05/29	Creation of Technical product TB 307 was recorded.
1.00	97/06/24	Updates in document TB004, TB005 and TB006 were recorded
1.00	97/06/25	Several minutes of meetings were approved
1.00	97/07/02	Binder Labels were updated
1.00	97/09/25	Several documents were updated and those were captured
1.00	97/10/07	Several documents were updated and those were captured
1.00	98/01/14	Documents and revisions were updated and checked
1.00	98/03/11	Updates were prior to an audit
1.00	98/07/01	Updates were made prior to an audit
1.00	99/03/22	Final changes were made prior to submission

Management Authorisation

Version	Date	Status	Management Board Minute Reference
1.00	96/06/24	Approved	TB 506

Change Forecast

This document will be updated each time a new documented element is added into SADDiN.

1 Scope

1.1 Introduction

An essential feature of a quality management system is that it documents the procedures used to implement and maintain the system. This document is the Document Master List which provides a directory of all documents which have the status of Draft, Provisional or Approved.

1.2 Purpose

This Document Master List provides the cross reference to all documents comprising the SADDiN

1.3 Applicability

This document is an essential reference to all documents supported in the SADDiN

1.4 Definitions

AFRICON: IEEE Conference in Africa

SAUPEC: South African Universities Power Engineering Conference

IEEE: Institute of Electrical and Electronic Engineering

PES: Power Engineering Society (of IEEE)

SADDiN: Software for Automated Design of Distribution Networks

1.5 Audience

The audience for this document comprise the various stakeholders of the SEAL, including:

- The product developer, namely T Rajakanthan
- The Product manager, namely Mr A S Meyer
- Software co-ordinator, Dr B Dwolatzky
- All full-time and part-time post-graduate students associated with the SEAL

- Members of the SEAL Management Board
- Head of the Department, Electrical Engineering
- Individuals who will perform internal and external surveillance audits of the SEAL Quality Management System

1.6 Applicable Documents

1.6.1 Standards

a. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 1.00, 3 October 1994.

1.7 Assumptions

It is assumed that the reader is familiar with the ISO 9000 series standard *for quality systems management.*

1.8 Requirements Traceability

This document addresses the following requirements:

a) ISO 9001 (1994) 4.5 Document and Data Control

b) ISO 9001 (1994) 4.16 Quality Records

1.9 Procedures

1.9.1 Entering data in the Summary Information File (Alt FI)

a) Title: Enter the name of the document being created

b) Subject: Enter the name of the project or abbreviate the name of the project QMS

c) Author: The name of the person creating this file

d) Keywords: The document code and serial number

e) Comments: The document revision number.

1.9.2 Document Front Page

a) Document project title: Instantiate from Summary Information File data SIF) using left mouse button to select field, click on right mouse button to bring up menu, select 'update field' and click on that item. The field selected will then be automatically updated with the data in the SIF.

b) Document title: Select field and instantiate from SIF.

c) Management/Technical Product: Edit to read Techn.. l or Management Product.

d) Version: Select field and instantiate from SIF.

e) Document Status: Edit to read Draft, provisional or approved.

1.9.3 Using the Configuration Control Table

All elements of the table are instantiated from the SIF.

1.9.4 Using the Document History Table

a) Version: The revision number of the new document

b) Date: The date on which the new revision was created.

c) Status: The status of the created document

d) Who: The author of the updated revision

e) Saved as: the file name (only - no path) of the new document

1.9.5 Using Document Revision Table

a) Version: The revision number of the current document

b) Date: The date on which this revision was updated.

c) Changes: A short description of the nature and location of the changes to the document

1.9.6 Entering details in Master Document List Table

The List is used as follows:

a) Document Name: A descriptive name for the document

b) Document Number: A unique serial number for the artefact

c) Revision Date: The date on which the artefact was modified, or entered into the system, as appropriate.

d) Document Status: For Management and Technical Products this will be Draft, Provisional or Approved. For records this field a '-' is entered since records are not subjected to revision.

e) Date approved: This will be the date of the Management Review meeting.

f) Minute reference: The date of the review meeting and the section of the minutes in which approval for the artefact was recorded.

g) File reference: If the document is in electronic format, the full file path and document name is entered, starting from the SEAL project number as the root. If the document is available in hard copy format only, the term 'Hard copy' is entered.

1.9.7 Revision Control of this document

a) When this document is created from QST 001-10 it is assigned a Revision of 0.01.

b) Once it is approved by the appropriate authority it is raised to Rev 1.00

c) After each internal audit the revision level is raised by a minor point i.e. following the first audit the revision number will be raised to 1.01. (This allows the MDL to be used to record the document baseline to be recorded immediately preceding the audit.)

d) In a one-person project the Project Initiation Audit is used to raise the document to 1.00 status.

e) For each revision change a new file is created.

f) Between document revisions the Change Control element (Revision History) is used to record the changes to the entries in the List, typically in terms of documents (or records) added or updated. These changes will typically refer to new artefacts (records) added in terms of document number, or the identify of which artefacts have been subjected to updates (technical and management products) This list of changed or updated documents is used to create the entries for the project Document Issue Notices, which are issued periodically to advise clients of the QMS of new or updated artefacts available.

2 Master Document List

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
MANAGEMENT PRODUCTS							
Master Document List	TB 001	1.00	99/03/22	Approved	96/06/22	TB506	1996_34\mp\TB001.100
Document Creation Template	TB 002	1.00	96/04/30	Approved	96/06/22	TB506	1996_34\mp\TB002.100
Project Quality Plan	TB 003	1.00	96/12/19	Approved	96/06/22	TB506	1996_34\mp\TB003.100
Product Description	TB 004	1.00	98/01/14	Approved	96/06/23	TB506	1996_34\mp\TB004.100
Project Management Plan	TB 005	1.00	98/03/11	Approved	96/06/22	TB506	1996_34\mp\TB005.100
Work Breakdown Structure	TB 005-10	1.00	98/03/11	Approved	96/06/22	TB506	1996_34\mp\TB00510.100
Configuration Management Plan	TB 006	1.00	92/03/22	Approved	96/06/22	TB506	1996_34\mp\TB006.100
Backup Register	TB 006-10	1.00	97/06/24	Approved	96/06/22	TB506	1996_34\mp\TB006-10.100
Contract	TB 007						
Binder Labels	TB 008	0.01	97/07/02	Draft			1996_34\mp\TB008.001
Archive Diskette Labels	TB 009	0.01	96/10/15	Draft			
Minutes of meetings Template	TB 010	1.00	96/03/04	Approved	96/03/04	N/A	1996_34\mp\TB010.100

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Document Issue Notice Template	TB 011						
Call for Review Template	TB 012						
Project Issue Report Template	TB 013						
Product Exception Report Template	TB 014						
Inspection and Review Template	TB 015						
TECHNICAL PRODUCTS (Project Overview)							
Project: Front Pages	TB 100	1.00	98/02/14	Approved	99/02/04	TB 533	1996_34\tp\TB100.100
Initial Research Proposal	*TB 101*	1.00	96/03/04	Approved	96/03/22	TB502	1996_34\tp\TB101.100
Progress Report 1	TB 102	1.00	96/06/20	Draft			1996_34\tp\TB102.100
Overall Research Proposal	TB 103	1.00	96/12/19	Approved	97/01/14	TB515	1996_34\tp\TB103.100
Project Introduction	TB 105	0.01	98/04/17	Draft			1996_34\tp\TB105.001
Project Summary/ Overview	TB 110						
Project Technical Paper	TB 120						

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Project: Conclusions and Recommendations	TB 130	1.00	98/10/12	Approved	99/02/04	TB 533	1996_34\tp\TB130.100
Project: Bibliography and references	TB 140	1.00	97/05/03	Approved	99/02/04	TB 533	1996_34\tp\TB140.100
Literature Survey	TB 145 / A2	1.00	99/02/12	Approved	99/02/04	TB 533	1996_34\tp\TB145.100
Literature Survey	TB 150 / B2	0.01	96/02/12	Approved	99/02/04	TB 533	1996_34\tp\TB150.100
TECHNICAL PRODUCTS (Product Development)							
Product Functional Specification - Mini Project: DXF - Map	TB 200/	1.00	96/08/25	Approved	96/08/25	TB 008	1996_34\tp\dxf_map\docs\TB200.100
User Reference Manual	TB 210 / C1	1.00	96/08/25	Approved	96/08/25	TB 008	1996_34\tp\dxf_map\docs\TB210.100
Product Test Specification	TB 220	1.00	96/08/25	Approved	96/08/25	TB 008	1996_34\tp\dxf_map\docs\TB220.100
High Level (Architectural) Design	TB 230 / C2	1.00	96/10/14	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\docs\TB230.100
Low Level (Detailed) Design	TB 240 / C3	1.00	96/10/14	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\docs\TB240.100
Code Design/Description	TB 250	1.00	96/10/14	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\docs\TB250.100
Code archive	TB 260	1.00	96/10/14	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\docs\TB260100.ARJ
Technical Reference Manual	TB 270	N/A					

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Product Verification and Validation	TB 280	1.00	96/08/25	Approved	96/08/25	TB 008	1996_34\tp\dxf_map\docs\TB280.100
Product Functional Specification: Main Research	TB 300	1.01	97/09/04	Approved	97/01/14	TB 515	1996_34\tp\docs\TB300.101
Introduction	TB 301						
Technical Paper 1	TB 302	0.04	97/03/03	Draft			1996_34\tp\TB302.004
Automated Reticulation	TB 303	0.01	97/01/31	Draft			1996_34\tp\TB303.001
Paper 1: Intelligent Maps	TB 304	1.00	97/08/17	Approved	97/07/17	TB 522	1996_34\tp\TB304.100
Paper 1: Intelligent Maps (CAP)	TB 304-10	1.00	97/08/17	Approved	97/07/17	TB 522	1996_34\tp\TB304-10.101
Paper 2: SAUPEC Paper	TB 308-10	1.00	97/11/14	Approved	97/11/14	TB 528	1996_34\tp\TB308-10.101
Paper 3: PES Paper	TB 309-10	0.11	98/12/04	Approved	99/02/04	TB 533	1996_34\tp\TB30910.100
User Reference Manual	TB 310						1996_34\tp\TB310.001
Problem Statement and Functional Specifications: "intelligent" map	TB 313 / A1	1.00	98/01/10	Approved	99/02/04	TB 533	1996_34\tp\TB313.100
Conceptual Design: "Intelligent map"	TB 315 / A3	0.02	98/06/24	Approved	99/02/04	TB 533	1996_34\tp\TB315.100
Product Test Specification	TB 320						1996_34\tp\TB320.001

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Problem Statement and Functional Specifications: transformer zoning	TB 325 / B1	0.04	98/04/21	Approved	99/02/04	TB 533	1996_34\tp\TB325.100
Conceptual Design: Transformer zoning	TB 328 / B3	0.01	98/06/02	Approved	99/02/04	TB 533	1996_34\tp\TB328.100
High Level Design: Transformer zoning	TB 330 / B4	0.05	98/06/02	Approved	99/02/04	TB 533	1996_34\tp\TB330.100
Low Level Design: Transformer zoning	TB 340 / B5	0.01	98/09/13	Approved	99/02/04	TB 533	1996_34\tp\TB340.100
Testing and Results: Transformer zoning	TB 345 / B6	0.01	99/01/14	Approved	99/02/04	TB 533	1996_34\tp\TB345.100
Code Design/Description	TB 350						1996_34\tp\TB350.001
Code archive	TB 360						1996_34\tp\docs\
Technical Reference Manual	TB 370						
Product Verification and Validation	TB 380						1996_34\tp\TB380.001
Future Work and Recommendations	TB 390						1996_34\tp\TB390.001
Work contribution	D1						1996_34\tp\Appendix D.doc
Results Spreadsheets for township A	TB 400	0.01	98/08/15	Draft			1996_34\tp\Township A.xls

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Results Spreadsheets for township B	TB 410	0.01	98/08/15	Draft			1996_34\tp\Township B.xls
Results Spreadsheets for township C	TB 420	0.01	98/08/15	Draft			1996_34\tp\Township C.xls
Results Spreadsheets for township D	TB 430	0.01	98/08/15	Draft			1996_34\tp\Township D.xls
Results Spreadsheets for township E	TB 440	0.01	98/08/15	Draft			1996_34\tp\Township E.xls
TECHNICAL PRODUCTS (*Project specific)*							
DXF to MAP file conversion Project. (002-005)	TRA 001	1.00	96/10/04	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\TRA00101.ide
Linked List associated classes - header	TRA 002	1.00	96/10/04	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\TRA00201.h
Linked List associated classes - CPP file	TRA 002	1.00	96/10/04	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\TRA00201.cpp
Windows related resources	TRA 003	1.00	96/10/04	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\TRA00301.rc
*Windows resources associated header file	TRA 003	1.00	96/10/04	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\TRA00301.rh
Windows related classes and conversion algorithms	TRA 004	1.00	96/10/04	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\TRA00401.cpp
*Windows definition file	TRA 005 (defs)	1.00	96/10/04	N/A			bc5\include\owl\defs.h

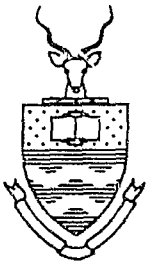
Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Application	TRA 006	1.00	96/10/04	Approved	96/10/14	TB 010	1996_34\tp\dxf_map\TRA00601.exe
QUALITY ASSURANCE PRODUCTS (Correspondence)							
E-mail distribution list for stakeholders	*TB 1000*						\qa\
Correspondence items	TB 1001 ->						\qa\corres\
QUALITY ASSURANCE PRODUCTS (Agenda's and Minutes)							
Minutes: Project Meeting	TB501	1.00	96/02/12	Approved	96/03/22	TB502	\qa\minutes\960212-1.min
Minutes: Project Meeting	TB502	1.00	96/03/22	Approved	96/05/03	TB503	\qa\minutes\960322-1.min
Minutes: Project Meeting	TB503	1.00	96/05/03	Approved	96/05/24	TB504	\qa\minutes\960503-1.min
Minutes: Project Meeting	TB504	1.00	96/05/24	Approved	96/05/27	TB516	\qa\minutes\960524-1.min
Minutes: Project Meeting	TB505	1.00	96/06/07	Approved	96/06/10	TB516	\qa\minutes\960607-1.min
Minutes: Project Meeting	TB506	1.00	96/06/22	Approved	96/06/23	TB516	\qa\minutes\960620-1.min
Minutes: Project Meeting	TB507	1.00	96/07/05	Approved	96/0708	TB516	\qa\minutes\960705-1.min
Minutes: Project Meeting	TB508	1.00	96/08/25	Approved	96/08/25	TB516	\qa\minutes\960825-1.min
Minutes: Project Meeting	TB509	1.00	96/10/02	Approved	96/10/14	TB516	\qa\minutes\961002-1.min
Minutes: Project Meeting	TB510	1.00	96/10/14	Approved	96/10/14	TB516	\qa\minutes\961014-1.min
Minutes: Project Meeting	TB511	1.00	96/10/15	Approved	97/01/14	TB516	\qa\minutes\961015-1.min

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Minutes: Project Meeting	TB512	1.00	96/10/16	Approved	97/01/14	TB516	\qa\minutes\961016-1.min
Minutes: Project Meeting	TB513	1.00	96/10/17	Approved	97/01/14	TB516	\qa\minutes\961017-1.min
Minutes: Project Meeting	TB514	1.00	96/11/29	Approved	97/01/14	TB516	\qa\minutes\961018-1.min
Minutes: Project Meeting	TB515	1.00	96/12/19	Approved	97/01/14	TB516	\qa\minutes\961219-1.min
Minutes: Project Meeting	TB516	1.00	97/02/26	Approved	97/03/24	TB518	\qa\minutes\970226-1.min
Minutes: Project Meeting	TB517	1.00	97/03/03	Approved	97/03/24	TB518	\qa\minutes\970303-1.min
Minutes: Project Meeting	TB518	1.00	97/03/24	Approved	97/06/25	TB519	\qa\minutes\970324-1.min
Minutes: Project Meeting	TB519	1.00	97/04/12	Approved	97/06/25	TB520	\qa\minutes\970412-1.min
Minutes: Project Meeting	TB520	1.00	97/05/02	Approved	97/06/25	TB521	\qa\minutes\970502-1.min
Minutes: Project Meeting	TB521	1.00	97/06/13	Approved	97/07/02	TB522	\qa\minutes\970613-1.min
Minutes: Project Meeting	TB522	1.00	97/07/02	Approved	97/07/17	TB523	\qa\minutes\970702-1.min
Minutes: Project Meeting	TB523	1.00	97/07/17	Approved	97/07/20	TB524	\qa\minutes\970717-1.min
Minutes: Project Meeting	TB524	1.00	97/07/20	Approved	97/08/11	TB525	\qa\minutes\970720-1.min
Minutes: Project Meeting	TB525	1.00	97/08/11	Approved	97/09/22	TB526	\qa\minutes\970811-1.min
Minutes: Project Meeting	TB526	1.00	97/09/22	Approved	97/10/07	TB527	\qa\minutes\970922-1.min
Minutes: Project Meeting	TB527	1.00	97/10/07	Approved	97/11/14	TB528	\qa\minutes\971007-1.min
Minutes: Project Meeting	TB528	1.00	97/11/14	Approved	97/12/05	TB529	\qa\minutes\971114-1.min
Minutes: Project Meeting	TB529	1.00	97/12/05	Approved	98/01/08	TB530	\qa\minutes\971205-1.min

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Minutes: Project Meeting	TB530	1.00	98/01/08	Approved	98/02/23	TB531	\qa\minutes\980108-1.min
Minutes: Project Meeting	TB531	1.00	98/02/23	Approved	98/03/04	TB532	\qa\minutes\980223-1.min
Minutes: Project Meeting	TB532	1.00	98/03/04	Approved	98/02/04	TB 533	\qa\minutes\980304-1.min
Minutes: Project Meeting	TB533	0.01	99/02/04	Draft			\qa\minutes\990204-1.min
	TB 2000						\qa\minutes
QUALITY ASSURANCE PRODUCTS (Audit reports)							
Project Initiation Audit	TB 3000	1.00	96/08/12	Approved	96/08/21		\qa\auditrep\9634PI.PAR
Project In process Audit	TB 3001	1.00	96/10/16	Approved	96/12/19		\qa\auditrep\9634IP01.PAR
Project In process Audit	TB 3002	1.00	97/01/15	Approved	97/01/20		\qa\auditrep\9634IP02.PAR
Project In process Audit	TB 3003	1.00	97/03/26	Approved	97/03/26		\qa\auditrep\9634IP03.PAR
Project In process Audit	TB 3004	1.00	97/06/25	Approved	97/06/27		\qa\auditrep\9634IP04.PAR
Project In process Audit	TB 3005	1.00	97/09/25	Approved	98/09/17		\qa\auditrep\9634IP05.PAR
Project In process Audit	TB 3006	1.00	98/01/15	Approved	98/01/17		\qa\auditrep\9634IP06.PAR

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
Project In process Audit	TB 3007	1.00	98/03/11	Approved	98/04/15		\qa\auditrep\9634IP07.PAR
Project In process Audit	TB 3008	1.00	98/07/02	Draft			\qa\auditrep\9634IP08.PAR
QUALITY ASSURANCE PRODUCTS (Document Issue Notices)							
	TB 4000						\qa\notices\
QUALITY ASSURANCE PRODUCTS (Call for Review)							
	TB 5000						\qa\reviews\
QUALITY ASSURANCE PRODUCTS (Project Issue reports)							
	TB 6000						\qa\issuerep\
QUALITY ASSURANCE PRODUCTS (Product Problem Reports)							
	TB 7000						\qa\problems\
QUALITY ASSURANCE PRODUCTS (Inspection and Review Records)							

Document Name	Document Number	Revision Number	Revision Date	Document Status	Date approved	Minute Reference	File Reference
	TB 8000						\qa\inspectns\
QUALITY ASSURANCE PRODUCTS (Backup and archives)							
Backup Register	TB 9000						\qa\backups\
QUALITY ASSURANCE PRODUCTS (Financial Records)							
	TB 10000						\qa\finance\



SADDIN

Configuration Management Plan

Management Product

Version 1.00

Document Status: Approved

Table of Contents

Table of Contents ii

Change History iv

Configuration Control iv

Document History iv

Revision History iv

Management Authorisation v

Change Forecast v

1 Scope 1

1.1 Introduction 1

1.2 Purpose 1

1.3 Applicability 1

1.4 Limitations 1

1.5 Audience 1

1.6 Applicable Documents 2

1.7 Requirements Traceability 2

1.8 Procedures for document updates 2

2 Documentation Structure 3

3 Artefact Identification 4

3.1 File Naming Convention 4

3.2 Project document and record sequence numbering 9

4 Artefact Management 10

4.1 Development Computer used for creating the files 10

4.2 Directory Structure of the Development Computer 10

4.3 Directory Structure of files supported on the SEAL File Server..... 11

5 Archiving of Artefacts..... 12

5.1 Electronic Artefacts..... 12

5.2 Backup procedure on computers in the SEAL Post-graduate Laboratory Facility..... 12

5.3 Backup of files to the SEAL FILE Server..... 12

5.4 Backup procedure on computers outside of the Chamber of Mines Building..... 13

5.5 Records of Backups\ Archives..... 13

5.6 Hardcopy Documents and Records..... 13

6 Configuration Status Accounting..... 14

7 Disk(ette) Backup Archive Register .....Error! Bookmark not defined.

Change History

Configuration Control

Project:	SADDIN
Title:	Configuration Management Plan
Doc. Reference:	C:\1996_34\MP\TB006.001
Created by:	T Rajakanthan
Creation Date:	17 May 1996

Document History

Version	Date	Status	Who	Saved as:
0.01	96/05/17	Draft	T R	TB006.001
1.00	96/06/22	Approved	T R	TB006.100

Revision History

Version	Date	Changes
0.01	96/05/17	New document created using QST12870.105
1.00	96/06/22	Document was approved
1.00	96/07/23	Backup with the use of CD was recorded in section 5.2.
1.00	96/09/30	Archival was recorded
1.00	96/10/02	Backup to seal server was recorded
1.00	96/10/05	Backup to seal server was recorded
1.00	96/10/10	Backup to seal server was recorded
1.00	96/10/14	Backup to seal server was recorded
1.00	96/12/20	Backup to seal server was recorded
1.00	97/01/15	Backup to seal server was recorded
1.00	97/03/25	Backup to seal server was recorded
1.00	97/03/24	Backup to Seal server was recorded
1.00	97/10/01	Code filenaming convention was modified
1.00	98/03/11	Code filenaming convention was modified
1.00	98/05/15	Document numbers of appendices were modified for modified for ease of referencing.

1.01	98/08/23	Changes were made to the filenaming conventions of the documentation

Management Authorisation

Version	Date	Status	Project Minute Reference
1.00	96/06/22	Approved	TB506.100

Change Forecast

1 Scope

1.1 Introduction

This document describes the configuration management plan applying to all artefacts supporting this project.

Such artefacts will include hardcopy and electronic representations of documents.

This document reviews the procedure which applies to the management and storage of these artefacts.

1.2 Purpose

Configuration items are individual documents and forms in electronic and hardcopy format. They comprise:

- management products and procedures
- technical products, and
- quality products

1.3 Applicability

To be referenced by all individuals who engage in product development for this project.

1.4 Limitations

This configuration management plan template is limited to use *on one-person projects*, or two person projects were one member is the developer (T Rajakanthan) and the other member is the Product Manager (Mr A S Meyer).

1.5 Audience

The following comprise the audience for this document:

a. The developer of this product, namely T Rajakanthan.

b. The manager of this product development, namely Mr A S Meyer.

c. The software co-ordinator, namely Dr B Dwolatzky.

d. Members of the SEAL Management Board

e. Head of Department of Electrical Engineering

f. Individuals who perform internal and external audits on projects undertaken within the SEAL Quality Management System.

1.6 Applicable Documents

1.6.1 Standards

a. SEAL QMS Document Layout, Presentation and Typesetting Guide, QS 003, Revision 1.00, 3 October 1994.

1.7 Requirements Traceability

a. ISO9001 (1994) 4.5 Document Control

b. ISO9001 (1994) 4.8 Product Identification and Traceability

c. ISO9001 (1994) 4.13 Control of Non-conforming Product

d. ISO9001 (1994) 4.16 Quality Records

1.8 Procedures for document updates

See QST001-10 for details on the use of the Change Control elements of this document.

2 Documentation Structure

The documents are categorised to reflect the nature of their content. The key categories of documents include:

- *management products,*
- technical products, and
- quality assurance products.

3 Artefact Identification

This section defines a consistent referencing system that shall be used for all artefacts. All artefacts are identified by both an artefact filename followed by a artefact file extension in the following format, as described in the following paragraphs.

<name>.<extension>

3.1 File Naming Convention

3.1.1 Project Products - Multiple word processor types present

The file name will be structured as follows:

AAXXXYY.ZZZ

Where AA is a 3-letter acronym for this project, namely TB

XXX is the 3 digit sequence number of this document,

YY is a file type identifier as follows:

- WS - Wordstar
- WP - Word Perfect
- - Word for Windows (No extension - default word processor type)
- AS - pure ascii text
- HC - hard copy file (no source present)
- PS - postscript file

ZZZ is the version number, starting from 001 as the initial version.

Example: QSM001AS.001, and interpreted as the document QSM001 of type ASCII and the first version in the sequence.

It should be noted that all the documents included in the paper model dissertation will have an alias for easier referencing. This referencing will simply constitute an alphabet, representing the appendix group, and a number indicating its position within that group.

3 Artefact Identification

This section defines a consistent referencing system that shall be used for all artefacts. All artefacts are identified by both an artefact filename followed by a artefact file extension in the following format, as described in the following paragraphs.

<name>.<extension>

3.1 File Naming Convention

3.1.1 Project Products - Multiple word processor types present

The file name will be structured as follows:

AAXXXYY.ZZZ

Where AA is a 3-letter acronym for this project, namely TB

XXX is the 3 digit sequence number of this document,

YY is a file type identifier as follows:

- WS - Wordstar
- WP - Word Perfect
- - Word for Windows (No extension - default word processor type)
- AS - pure ascii text
- HC - hard copy file (no source present)
- PS - postscript file

ZZZ is the version number, starting from 001 as the initial version.

Example: QSM001AS.001, and interpreted as the document QSM001 of type ASCII and the first version in the sequence.

It should be noted that all the documents included in the paper model dissertation will have an alias for easier referencing. This referencing will simply constitute an alphabet, representing the appendix group, and a number indicating its position within that group.

3.1.2 Project Products - Single word processor format used

The file name will be structured as follows:

AAAXXXXX.ZZZ

Where AAA is the 3 letter acronym for this project,

XXXX is the 3 or 4 digit sequence number of this document

and ZZZ is the version number of this file, starting from 001 as the initial revision. When a document is baselined as the first version, the most significant digit will represent the version number.

Example: The User Reference Manual (Version 2.00) for the SQM project will have the following file name: SQM003.200.

3.1.3 Code\ line art\ image files

The file name will be structured as follows:

TRAXXXYY.BBB

where TRA is a 3 letter acronym for the author of the project.

XXX is a 3 digit serial number

YY is a two digit version number, in the range 01 to 99, and starting from 01.

BBB is the file extension and will be whatever the particular compiler/tool demands.

Example: The third display module (Version 2.4) for the CART project could have the following filename: CDSP0324.CPP, if it was written in C++. For the mini project DXF-MAP this convention was adhered to.

An *.ide file is classified as an a project file which contains information about the various classes being utilised in a specific project.

A *.rc file contains information about all dialogue boxes being used in a specific project.

The all the code files for the project TOLP will be located in the directory :\1996_34\TP\TOLP\. For ease of use the above mentioned file naming conventions will not be used. All the filenames will be the same or an

abbreviation of the class it contains. Version control will be maintained purely by the text header located prior to the declaration of each class.

All source code file names use the long file naming convention as supported by the Windows '95 operating system.

Modules which only contain *template classes* are named as follows. The header file has a "hpp" extension while the body has a "cpp" extension. For example, "dllist.hpp" and "dllist.cpp".

Modules which contain *standard* classes have header files which are named with an "h" extension while the body files have a "cpp" extension. For example, "XfrLocator.h" and "XfrLocator.cpp".

3.1.4 Records - Naming Conventions

3.1.4.1 Correspondence

The file naming convention is as follows:

<YYMMDD><SS>.<RRR>

Where YYMMDD is the date on which the correspondence items were received,

SS - two characters are allowed for the initials of the sender, and

RRR - up to three characters are allowed for the receivers initials.

3.1.4.2 Minutes of Project Meetings

The application of TB 010 results in records of which the filename conventions are as follows:

<YYMMDD>-<N>.AGD, or MIN

where YYNMMDD is the date on which the meeting was held,

N is a serial number between 1 and 9, and

AGD identifies Agenda's, and MIN identifies Minutes.

3.1.4.3 Audit Reports

The file naming convention of the SEAL QMS is used when the SEAL QMS templates (QST 137-20 QST 137-30, QST 137-40) are applied:

<Project Year Serial Number><Audit Type><Audit serial number>.PAR

where Project Year and Serial number for this project is 9547 (i.e. SEAL Project 47 registered in 1995),

Audit type - can be PI (Project Initiation) IP (Project in Progress) and PC (Project Closure).

If the audit is an IP type, then the serial number will be in the range 01 to 99.

The filename extension PAR refers to Project Audit Report.

3.1.4.4 Document Issue Notices

The application of TB 011 generates records which have the naming convention of:

<YYMMDD>-<N>.DIN, where

<YYMMDD> is the date on which the notice was generated,

N is a serial number, allowing for multiple notices to be issued on one date, and

DIN refers to Document Issue Notice.

3.1.4.5 Call for Reviews

When TB 012 is applied, the quality records generated have the filename conventions of:

<YYMMDD>-<N>.CFR, where

YYMMDD is the date on which the Call for Review was issued,

N is a serial number in the range 1 - 9, and

CFR - Call for Review.

Response to Call for Reviews are stored as:

<YYMMDD>-<N>.RCR

where YYMMDD is the date on which the response to the Call for Review was received,

N is a serial number of the responses received on a particular date, and

RCR refers to Response to Call for Review.

3.1.4.6 Project Issue Reports

Responses to the application of TB 013 have the naming convention of:

<YYMMDD>-<N>.PIR, where

<YYMMDD> is the date on which the report was received,

N is a serial number, allowing for multiple reports to be received on one date, and

PIR refers to Project Issue Report.

3.1.4.7 Product Exception Reports

Responses to the application of TB 014 have the naming convention of:

<YYMMDD>-<N>.PER, where

<YYMMDD> is the date on which the report was received,

N is a serial number, allowing for multiple reports to be received on one date, and

PER refers to Product Exception Report.

3.1.4.8 Product Inspections and Reviews

The application of TB 015 generates records which have the naming convention of:

<YYMMDD>-<N>.IRR, where

<YYMMDD> is the date on which the review record was received,

N is a serial number, allowing for multiple reports to be received on one date, and

IRR refers to Inspection and Review Record.

3.1.5 Backups and Archives

The template for the register of backups and archvies is derived from QST 128-71. The register will be designated:

TB 9000.DOC (for a WW6 document type)

3.1.6 Financial Records

Since most of these will hard copies, the document number will simply be written on top right hand corner of the document.

In the instance of a request for quotation, these will usually be of the nature of a correspondence item, and so the naming convention described in Section 3.1.4.1 applies.

3.2 Project document and record sequence numbering

- The MP series will be from 001 to 099
- The TP series will be from 100 - 999
- The QA series will be from 1000 ->

4 Artefact Management

The controls adopted for this project are as follows:

4.1 Development Computer used for creating the files

SEAL Lab Computer System S-70 is the resident computer.

4.2 Directory Structure of the Development Computer

4.2.1 Drive Partition

The E Drive partition is used.

4.2.2 Project Directory of files on the Development Computer

- D:\1996_34\MP - for the storage of the management series documents
- D:\1996_34\TP - used for the storage of technical product
  - DXF_MAP - storage for items concerning the DXF-MAP mini-project.
- D:\1996_34\QA - used for the storage of quality assurance products including minutes of review meetings, audits of the system, and correspondence.
- The sub-directories of the QA directory are as follows:
  - CORRES - storage for correspondence items
  - MINUTES - storage of agendas and minutes of Core Group meetings
  - AUDITREP - storage for project audit reports
  - NOTICES - Storage for Document Issue Notices
  - REVIEWS - storage for Call for Review Notices and responses
  - ISSUEREP - storage for Project Issue Reports
  - PROBLEMS - storage for Product Exception Reports
  - INSPECTN - Storage inspections and review records.

* BACKUPS - storage for backup and archive records

* FINANCES - storage for records associated with financial transactions on the project

4.3 Directory Structure of files supported on the SEAL File Server

4.3.1 Project Directory

The home/SEAL_proj/1996_34 is used.

4.3.2 Project Directory Structure

- home/SEAL_proj/1996_34/mp - for the storage of the management series documents
- home/SEAL_proj/1996_34/tp - used for the storage of technical product
- home/SEAL_proj/1996_34/qa - used for the storage of quality assurance products including minutes of review meetings, audits of the system, and correspondence.
- The sub-directories of the QA directory are as follows:
  * corres - storage for correspondence items
  * minutes - storage of agendas and minutes of Core Group meetings
  * auditrep - storage for project audit reports
  * notices - Storage for Document Issue Notices
  * reviews - storage for Call for Review Notices and responses
  * issuerep- storage for Project Issue Reports
  * problems - storage for Product Exception Reports
  * inspectn - storage inspections and review records
  * backups - record of backups and archives on the project
  * finances - record of financial transactions on the project

5 Archiving of Artefacts

5.1 Electronic Artefacts

On project completion an archive copy of all electronic artefacts supporting this projects will be supplied on or more stiffy diskettes using the ARJ.EXE utility. These diskettes will be kept in the official SEAL plastic folders immediately inside the SEAL Project Binder.

5.2 Backup procedure on computers in the SEAL Post-graduate Laboratory Facility

Computers in the SEAL Laboratory Facility are subject to the following back-up procedure:

a. **Daily Backup:** Project files are archived to the stiffy diskettes kept inside the SEAL Project Binders. *(Risk covered: Failure on the hard disk or inadvertent loss or corruption of data.)*

b. **Weekly Backup**: Project files are archived to the Network Directory for that user. This action ensures that these project artefacts are archived to a site outside the SEAL Lab. *(Risk covered: Destruction or loss of the computers in the SEAL Lab by fire, theft, or other disaster.)*

c. **Backup to CD**. All projects will be backed up on CD on a monthly basis. This is an attempt to avoid further loss of data due to failure of devices in or associated with the SEAL lab.

5.3 Backup of files to the SEAL FILE Server

All projects associated with the SEAL are required to archive project files to the SEAL Server project directory on a regular basis.

a. **Backup Frequency to SEAL Server:** The frequency of backups from this project to the SEAL File Server will be weekly.

b. **Backup to the File Server**: All project files are archived to the SEAL Project Directory. This action ensures that these project artefacts are archived to a offsite from the Development Computer. *(Risk covered: Destruction or loss of the development computers by theft, fire or other disaster.)*

5.4 Backup procedure on computers outside of the Chamber of Mines Building

The tapes are kept offsite from the location of the resident computer in stiffy diskettes in the SEAL folder.

5.5 Records of Backups\ Archives

Records of backups\archives are maintained using the plate supplied in Section 7 of this document.

(Note: This template is also supplied as a separate document QST128-71).

5.6 Hardcopy Documents and Records

Are maintained in an official SEAL Project Documentation Binder in the Project File in Room CM2221 (SEAL Laboratory) in the chamber of mines building.

6 Configuration Status Accounting

The Project Manager is responsible for ensuring that status of artefacts recorded in the Master Document List corresponds to the:

- identify of the artefacts in the file directories, and
- The revision numbers are correct.

Author Rajakanthan T
Name of thesis Software Modules To Further Assis The Rapid Production Of Optimised Electrical Reticulation Schemes Rajakanthan T 1999

PUBLISHER:
University of the Witwatersrand, Johannesburg
©2013

LEGAL NOTICES:

Copyright Notice: All materials on the University of the Witwatersrand, Johannesburg Library website are protected by South African copyright law and may not be distributed, transmitted, displayed, or otherwise published in any format, without the prior written permission of the copyright owner.

Disclaimer and Terms of Use: Provided that you maintain all copyright and other notices contained therein, you may download material (one machine readable copy and one print copy per page) for your personal and/or educational non-commercial use only.

The University of the Witwatersrand, Johannesburg, is not responsible for any errors or omissions and excludes any and all liability for any errors in or omissions from the information on the Library website.