

Civil Engineering

Sivili Enjeneereng

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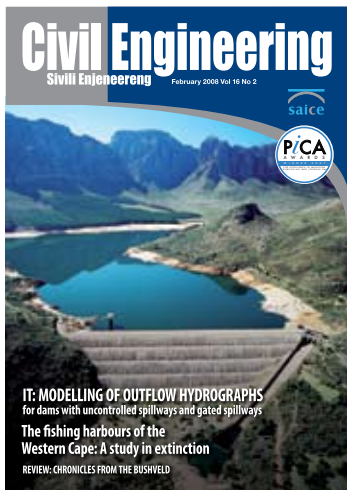
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IT: MODELLING OF OUTFLOW HYDROGRAPHS
for dams with uncontrolled spillways and gated spillways

**The fishing harbours of the
Western Cape: A study in extinction**

REVIEW: CHRONICLES FROM THE BUSHVELD



ON THE COVER

The Sorenson method for determining dam spillway outflows: a graphical method lost in the mists of university time, but a means to solve the iterations required for uncontrolled spillway flow calculations. Can this problem be resolved mathematically utilising the circular calculation capability built into spreadsheets and can the method be extended to gated spillways? (See article on page 3)



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INFORMATION TECHNOLOGY

Modelling of outflow hydrographs for dams with uncontrolled spillways and gated spillways

DAMS WITH UNCONTROLLED SPILLWAYS

The modelling of outflow hydrographs for dams with uncontrolled spillways is an iterative arithmetic process which lends itself well to spreadsheet calculation. The outflow period is broken up into discrete time increments to create a tabular format and inflows, outflows and other related data can be calculated for each time period. Modern spreadsheets (as opposed to earlier DOS versions) also have powerful charting capabilities where the copious amounts of tabulated input and output data can be conveniently summarised and presented in chart form.

A spreadsheet model for generating outflow hydrographs for uncontrolled spillways can be set up by a competent user utilising the above principles.

Gated spillways are more complicated even assuming a pre-set control sequence, which raises the question of whether these can also be successfully modelled by the same means.

HHO Africa was appointed by the City of Cape Town to undertake a study of the secondary use of Wemmershoek Dam for flood control purposes. This required modelling of the outflow hydrographs for the dam. The study was undertaken by Robert Blyth as consultant to HHO Africa and the author, Evan Bredekamp, technical director at HHO Africa. Time and budgetary constraints prevented the development of fully functional spreadsheet models at the time, but further analysis has resulted in the development of functional models that are described here.

The basic methodology for modelling uncontrolled spillways is

described in this section of the article and then extended to that of gated spillways with specific reference to Wemmershoek Dam. The author believes that the method can be applied generally to dams and other gate-controlled structures such as barrages.

Methodology for modelling of uncontrolled spillway discharges

Unless low-level outlets are in operation, outflow from a dam via its uncontrolled spillway would only result once the FSL (full supply level) is exceeded. For the production of outflow hydrographs, one is normally therefore only concerned with the behaviour of the reservoir and spillway at levels above the spillway. At storage levels below FSL, any inflow would simply be absorbed in raising the level of water in the dam until the FSL is reached. The rate of water level rise for this situation is then a simple function of the depth:capacity (depth:storage) curve.

Inflow into the dam is normally modelled by means of an inflow hydrograph which represents the flow generated by net rain on the catchment area – net rain being the actual rainfall less any losses due to infiltration, evaporation, etc. The inflow volume is therefore calculated from the inflow given by the hydrograph averaged over the time increment chosen for analysis

The base relationship of the model is that for each time increment, volume of inflow less volume of outflow results in change in storage – either positive or negative. A positive result means that inflow is higher than outflow and this will result in a rise in

reservoir level (increase in storage). A negative result, implying greater outflow, would conversely reduce the reservoir level and the total storage. The outflow component is calculated from the water level (height above spillway) utilising the discharge formula appropriate to the type of overflow spillway – for example weir flow over an ogee spillway.

From the resultant change in storage, a water level is calculated based on the depth–storage relationship for the particular dam.

This procedure is then repeated for each time increment using the volume of inflow and outflow for each successive time increment.

The relationship between storage and outflow is iterative. Hence each row of the spreadsheet represents a time increment during which an equilibrium is reached between inflow and outflow volumes and the resultant change in storage and water level. The equilibrium water level represents the average level for the time increment which will result in the inflow/outflow and change in storage equation being satisfied.

Variables

Time increment

The time increment can be virtually as small as one would like and is limited only by the processing power of the computer – the only advantage being that smoother charts result from smaller increments. At the other end of the scale, the interval should not be too coarse and should allow a reasonable number of points/values to be calculated relative to the length of the duration of the inflow hydrograph. A good rule-of-thumb is maintain the time increment at about 5% of the time to peak of the inflow hydrograph. For the examples shown a 15 minute interval has been utilised for a six-hour inflow hydrograph.

Inflow

This is usually in the form of an inflow hydrograph and is determined from the catchment reaction to nett rainfall. The hydrograph duration which produces the peak flow is usually analysed and in the example, a six-hour hydrograph has been utilised.

Outflow

The head–discharge relationship for the particular spillway is required which relates reservoir water level to discharge. It is also better to rewrite the relationship in terms of absolute levels (relative to mean sea level, MSL).

In the example an ogee spillway with crest length of 150 m has been utilised. The weir equation has therefore been used to determine outflow.

Storage

The depth–storage relationship for the dam is also required. This relationship is generally in a polynomial form to the third or sometimes fourth power with a single power relationship of the form $\text{Storage} = m \cdot \text{depth}^n$ being the most common, although not the most precise over the full range of reservoir water levels. This relationship should also be written in terms of the depth of the reservoir relative to MSL.

It must also be appreciated that the model assumes a level pool relationship in the calculation of storage. This is an approximation as it ignores the backwater effect of the inflow on

the reservoir but is generally accepted as in most cases the error is small.

Results

The chart shows the summarised data resulting from the steps outlined above. In this particular example, the model represents Wemmershoek Dam, but with an alternative 150 m ogee spillway at the FSL instead of the actual gated spillway. This therefore illustrates the case of an uncontrolled spillway in routing a 200 mm six-hour inflow hydrograph.

The model predicts that a 150 m ogee spillway in place of the current gate system at Wemmershoek would result in a peak outflow of 507 m³/s with a maximum water rise of 1,52 m above FSL. This amounts to an attenuation of approximately 23% compared to the peak inflow of 660 m³/s.

DAMS WITH GATED SPILLWAYS

The spillway of Wemmershoek Dam is controlled by a set of three curved crest Tainter gates each 8,7 m wide. Under rising water level conditions, the middle gate opens first in a predetermined sequence triggered by specific reservoir water levels. The different openings (and linked discharges) are referred to as stages of operation – for example Stage 1 opening is 150 mm, releases 16 m³/s and is triggered by water level rising through 40 mm above FSL.

This gate is fully open at Stage 10 and at the next stage, the two side gates come into simultaneous operation – in theory continuing through to Stage 19 when all three gates would be fully open and discharging at 1 104 m³/s. In order to prevent hunting of the gates on falling water levels, a lower stage will only be triggered at water levels one stage lower than that on rising levels. For example, while Stage 1 opening is triggered at 40 mm above FSL, movement of the middle gate to close will only be triggered once water levels drop to FSL, that is, a one stage lower trigger level.

It is worth noting that the current system of operation was developed in 1968, before computer analysis was available. It has the advantage of being simple to operate and therefore does not require specialised operating staff. This approach also allows for a simpler installation and gate operation as the opening and closing sequences are identical.

For example, on rising water levels, the middle gate opens first to 150 mm, then to 460 mm, 760 mm and so on. In closing, this gate would drop to 760 mm from the stage above, then to 460 mm, 150 mm and finally close. The same position detectors or stops on the gate can therefore be used for both opening and closing sequences.

The trigger levels are identical – that is a water level rising through 40 mm above FSL will trigger the gate to open to 150 mm while a water level falling through 40 mm will trigger the gate to close from 460 mm to 150 mm – off-set by one step in terms of trigger levels. The same water levels and detectors (for example float switches) can therefore also be used to trigger a gate movement.

First attempts

Initial models were set up on the same iterative basis as for the uncontrolled spillway as previously described. These models proved unstable and the following reasons have been deduced;

A gate is either open or closed – a simple statement, but implying, with hindsight, that an iterative procedure could be



- ① Aerial view of Wemmershoek Dam – spillway chute in the foreground
- ② Central gate discharging – winter 2002

avoided. An uncontrolled spillway is in a sense self-regulating in that the level above spillway is a function of the capacity of the spillway and the inflow. The iterative procedure described above for the uncontrolled spillway mimics this regulation by calculating the average level above spillway satisfying outflow and storage for the time increment under consideration.

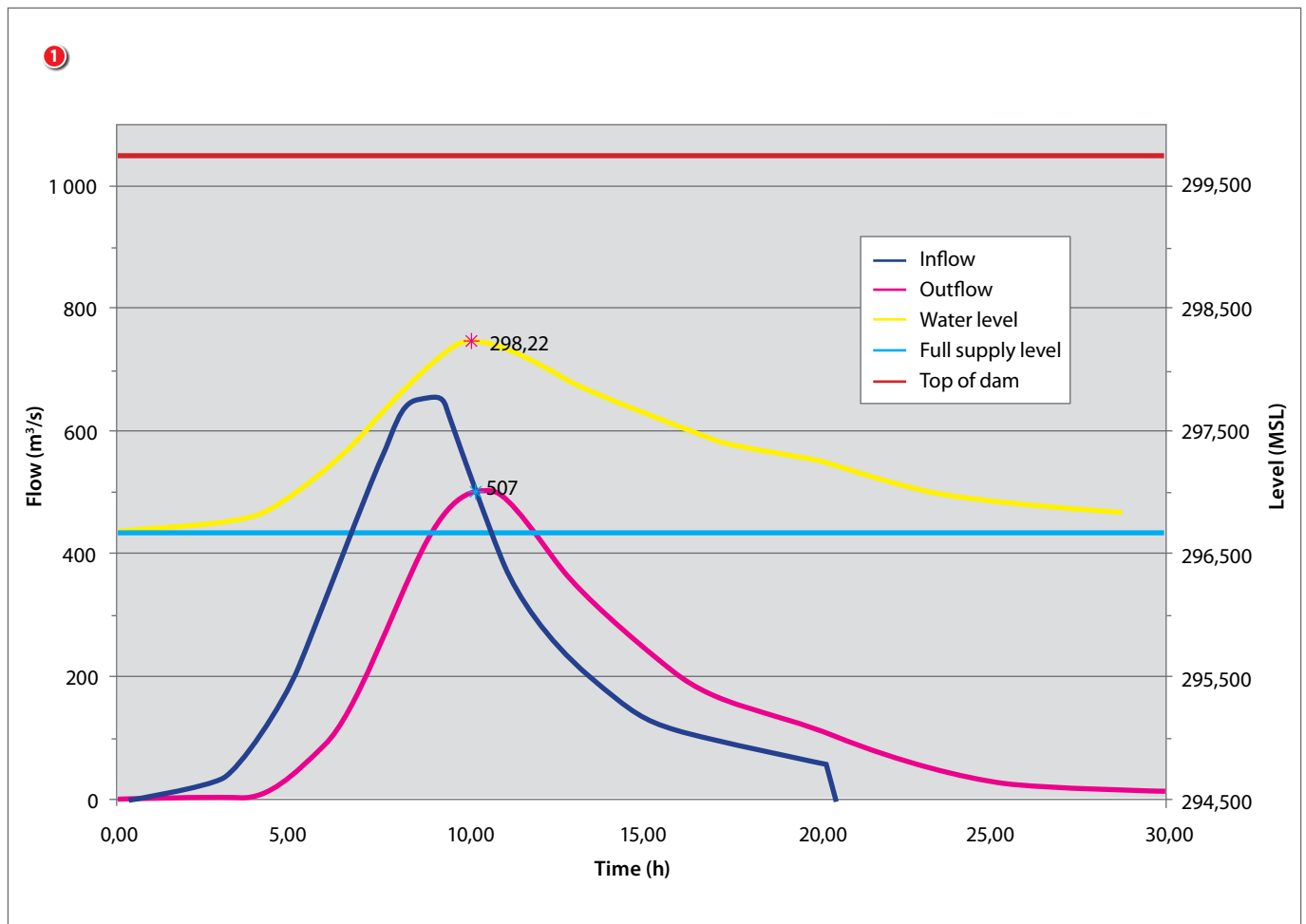
For a gated spillway, the gate sequence is chosen and outflow can therefore be delayed, set lower or even set higher than inflow depending on the control that is required. In the model presented, no iteration is utilised and the gate is set at a particular opening for the entire time increment. The time increment can be reduced to improve the model accuracy if this is required.

Furthermore, instances arose where, on the first iterative pass in one time increment, a too small gate opening led to a rise in water level triggering a bigger opening. On the next iterative pass, the bigger gate opening would be in operation, lowering the water level to such an extent that it triggered the previous smaller gate opening – resulting in an unstable loop with no solution.

Revised methodology

The same basic logic as for uncontrolled spillways, but without iteration, was eventually applied, that is, inflow volume less outflow volume being used to calculate the resulting storage and the storage used to calculate a new water level.





The difference applied was that the outflow volume for the current time increment was calculated from the gate opening at the end of the previous time increment to produce a new water level. The gate position at the end of the current time interval was then established from the new water level. The gate opening was therefore set for the whole of the current time increment and a change would only be possible in the next time increment.

Modelling of the current opening and closing sequences at Wemmershoek Dam was accomplished by means of a look-up table.

Two outflow conditions can occur with gate control, firstly submerged flow when the water level is above the lip of the gate and secondly, weir or free flow conditions. Outflow equations for the gate(s) were modelled for both submerged and weir flow conditions with a logic condition to determine the appropriate flow equation to be utilised. An additional refinement to submerged flow conditions was also modelled as the coefficient of discharge was found to vary based on gate opening size. This is explained in more detail below.

Variables

Time increment

In terms of creating an accurate model, the modelled time increment should not differ substantially from what has been set in practice – that is, the actual time intervals for monitoring of the reservoir depth. For instance, if modelled time increments are substantially less than those at which levels are actually monitored, the model will react faster than what occurs in actual operation.

A practical constraint is that the actual time interval for monitoring should not be less than the gate reaction time, that is, once triggered, the gate should reach its new position before

the next reading is taken. If this is not the case, then in practice certain gate openings could be bypassed. If this is desirable or of no consequence, this recommendation can be ignored.

Inflow

This is modelled identically to the uncontrolled spillway case.

Outflow

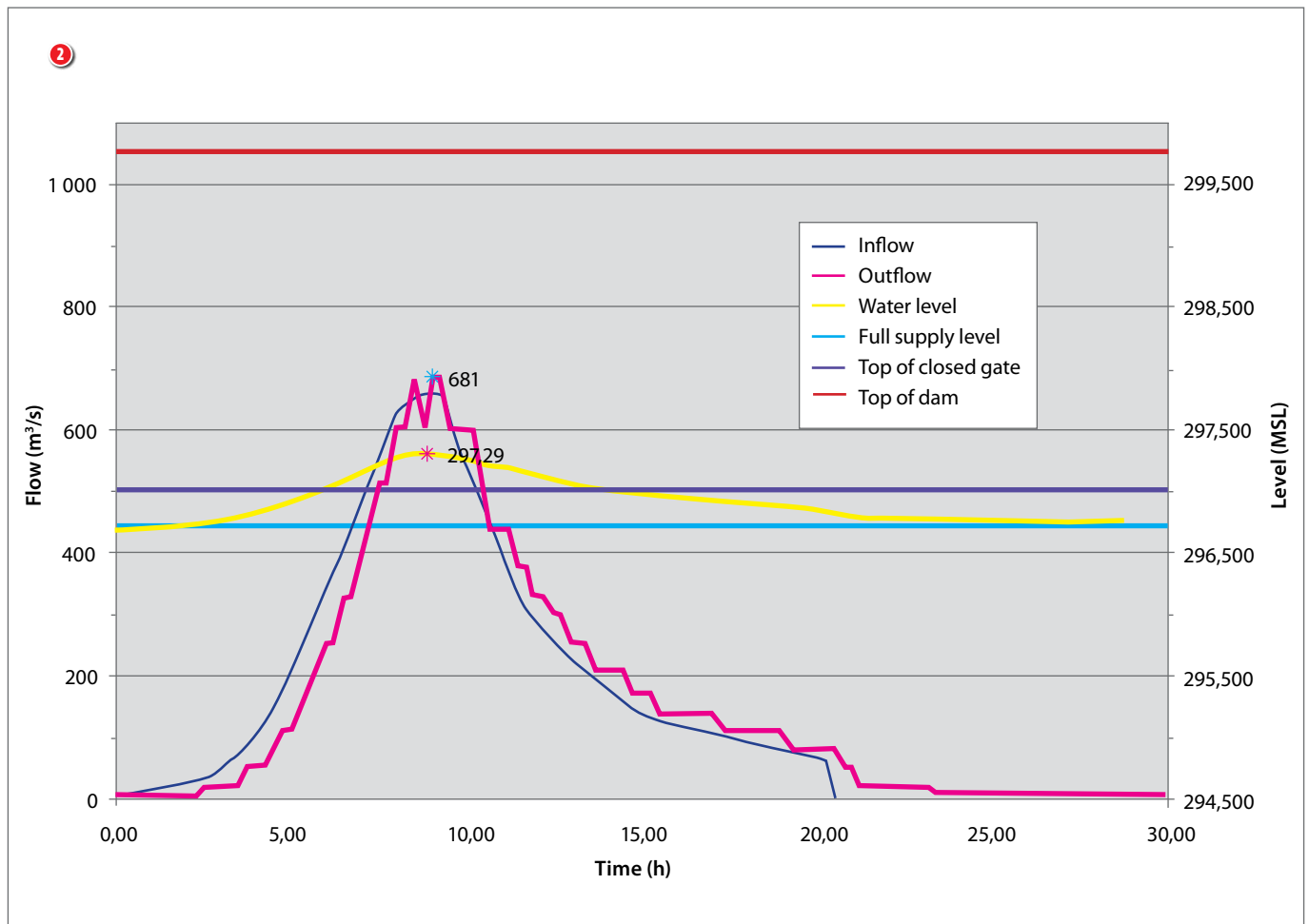
Generally, gated spillways operate on the basis that a particular gate(s) would open a pre-determined amount once a certain water level is reached – the different stages as described above.

The stages of the Wemmershoek Dam opening sequence were modelled by means of a look-up table in the spreadsheet. The look-up table returned the gate level based on the water level and the opening size was then utilised to calculate outflow.

Two cases were catered for in calculating the gate outflow – submerged flow, which utilised the orifice equation, and weir flow, to model the case of free flow over the spillway. This condition would generally be met with the gate in the fully open position. In checking for a submerged versus weir flow condition, no allowance was made for draw-down of the water surface level.

Hence if the calculation showed that the water level was higher than the bottom of the gate when open, submerged flow was utilised.

The opening sequence for Wemmershoek Dam is listed in the operating manual for the dam and details the trigger level, gate opening and flow. For the model, the flow given in the table was back-analysed to determine the discharge co-efficient (C_d) for the different flows. This was plotted against opening size to determine the relationship between gate opening and C_d .



① Modelled outflow for Wemmershoek Dam

– theoretical 150 m ogee spillway

① Modelled outflow for Wemmershoek Dam – gated spillway

It was found that two distinct relationships resulted – one for ‘small’ openings and one for ‘large’ openings. The change in C_d occurred where the ratio of head (measured to the middle of opening) to opening height exceeded 0,9. This was incorporated into the model with the net result that the tabulated flows as listed in the operation manual have been reproduced in the model.

Storage

This is calculated as before with storage at the end of each time increment determined from initial storage plus inflow volume less outflow volume.

As no iteration is required, the calculation required is that of determining the water level from storage at the end of each time increment.

Diagram 2 summarises the results of the analysis and again shows inflow, outflow and dam level resulting from the model for a gated spillway. The model appears to correctly reflect the envisaged operating procedure and shows the steps in outflow expected when compared to the smoother outflow of an uncontrolled spillway.

Results

For the particular Inflow hydrograph, the diagram also highlights one of the drawbacks of gate-controlled spillways – that the potential exists for the outflow to be higher than inflow depending on the incoming flow and gate operating sequence.

The model also predicts an instance of 'hunting' at the peak discharge time.

It must be stressed that the model remains only a prediction of the actual situation. The model is governed by the underlying logic and assumptions in the spreadsheet and in particular, the time increment chosen for the analysis. For any definitive conclusions to be drawn, this would have to be tested against the actual gate control in the field. In the context of the magnitude of inflows, the predicted outflow is only marginally higher than the inflow, the difference, in all probability, falling within the range of accuracy of the model.

In practice, the presence of the reservoir also attenuates the peak of the hydrograph to a greater extent. In the model, inflow is immediately translated into a change in storage and a change in levels. This would not occur in practice as inflows would lead to a more gradual change in levels.

For the same inflow hydrograph as input previously for the theoretical uncontrolled spillway, the model for a gated spillway predicts no attenuation and that the current gate sequence will produce a peak flow of 681 m³/s with a maximum water rise of 0,59 m above FSL.

CONCLUSION

Based on the models of the Wemmershoek Dam, the conclusion is made that a spreadsheet can be utilised to successfully model an uncontrolled spillway and the more difficult case of gated spillways – albeit with the latter requiring additional effort. This


effort would clearly be worthwhile should there be a need to model various scenarios for a particular dam.

It would be impractical to set up a generalised workbook to cater for any reservoir with gate control. The model should rather be set up for a particular dam with careful consideration given to incorporating flexibility in terms of the parameter to be tested such as data input for hydrographs or gate opening sequences.

For this exercise, the current gate sequence at Wemmershoek was reproduced. An area for further study could include a method for generating and testing additional gate sequences as well as allowing for draw-down of the water surface in the logic control for orifice versus weir conditions.

Rewriting the different equations to utilise or produce reduced levels based on MSL is a useful tool which allows direct comparison with critical levels at the dam site.

In undertaking this exercise, certain practical issues have also been highlighted which would need to be addressed operationally. These would include the length and frequency of the monitoring interval for actuating gate operation and how the logic of preventing hunting of gates and the switch to the closing sequence is incorporated in practice – especially if the gates are meant to operate automatically.

Finally, the problems encountered in developing the models have served to reinforce the value of an engineer undertaking the programming solution. The difficulties encountered have contributed to a better understanding of potential operational problem areas. 



Business information systems

Engineering's orphan child

THIRTY ONE YEARS ago I graduated as a civil engineer with a distinct dislike for computers, having studied Computer Science in the days of card punches and long queues in the computer centre waiting to find one more punch error in my deck of cards.

I undertook research for my PhD in Materials Science, bought a personal computer in the days of the original Apple computer and found that getting the computer to do what the salesperson told me it could do was not that easy.

For the last eighteen years I have been providing professional advisory services with regard to the effective application of computer technology in support of business – so, what happened?

Over time we have seen a transformation in the capability and affordability of computer technology to the point where today, computers are a ubiquitous part of every aspect of modern life.

Yet we find that many organisations that invest in large computerised business systems are dissatisfied with their investments and dramatic project failure is regularly reported.

In about 1993 I became aware that about 70% of business computer investments failed to deliver any result whatsoever and that a further 20% failed to meet business expectations. Overall the situation has not changed much in the past fifteen years except that the magnitude of the failures has, if anything, become greater.

The syndrome that I experienced in 1981 of finding that the promised benefits were much more difficult to attain than

the sales person suggested continues to be a common experience today.

In the last fifteen years I have published much about the factors causing failure and what is required for successful outcomes. Today I want to specifically address the subject from a perspective that is very close to my heart – the application of the disciplines and art of engineering to the successful application of computer systems in business.

Even today, the engineering profession continues to keep its distance from the business application of computers.

From time to time I encounter other graduate engineers employed in the practice of engineering with regard to the business application of computer systems. However, graduate engineers are in the minority amongst those who engage in the application of computers to support business and there is no formal track for certification of practitioners in this field as professional engineers.

There are many engineers who practise in the field of computer system and device design and fabrication and software engineering in the sense of the technical development of software technology and 'software engineering' is a reasonably widely used term. This is not what I am writing about.

This article relates to the art and science of conceptualising, analysing, designing and guiding the implementation of complex computerised solutions for use in managing and directing business.

In my experience this is just as much a form of engineering as the creation of large engineering structures and other

systems where it is taken for granted that engineers will be involved as core members of the project team and where, in fact, it is a statutory requirement that certified professional engineers will hold overall technical responsibility for the project.

There are severe sanctions for professional engineers who fail to exercise their responsibility of care for the success of the project outcome with due diligence, let alone the severity of sanctions that apply in the event of a failure that results in injury or loss of life.

In 2006, it was reported that:

- After spending seven years and close to half a billion dollars implementing a mainframe ERP system (business information system), a major US chemicals company stopped and started over with a client-server version
- A global athletics footwear manufacturer wrote off \$400 million against their supply chain management system
- A major US entertainment company wrote off \$878 million against its web portal

Can you imagine the outcry if such write-offs were experienced with major civil engineering projects resulting in large, desolate construction sites which had to be demolished and the rubble removed in the public eye?

WHY DOES THIS HAPPEN?

There are a number of critical factors that give rise to this situation, they include a lack of strategic insight – insight into why the business exists and how it thrives, lack of executive custody – a proprietary sense

of ownership of the business outcome by business executives, lack of effective, disciplined project governance and management, lack of attention to the data content and every now and then some genuinely technical issue.

Today I want to address one aspect in particular that causes failure – the lack of an engineering approach.

An engineering approach is a systematic, methodical, rigorous, accountable way of working that contains checks and balances, involves diverse professional disciplines and which is directed at ensuring a successful outcome by preventing failure.

Engineering projects seldom fail because we, as engineers, are weaned in the art and practice of engineering by reports of failure, discussion of factors of safety and discussion of the probability of failure in the event that we fail to discharge our professional responsibility with due care.

Should an engineering project fail, even years after completion, it is widely reported in the public press and in the journals and conference proceedings of the engineering profession. Failures are the subject of investigations and reports and methods of preventing recurrence are debated and documented.

This approach is so effective that a major engineering failure such as the bridge collapse in the US last year results in immediate headlines around the world. Society is so conditioned to trust in the veracity and reliability of engineering practice that it is a tremendously newsworthy event when failure does occur.

Yet business information system failures of substantial dollar value are quietly dismissed and even brushed under the carpet. In one case the corporation shredded every document in the project office!

Various authoritative voices are calling for legal accountability of corporate directors in the event of business information system failure that results in losses to the business or damage to the business.

At the 2006 Information Technology Governance Summit it was suggested that it is only a matter of time before shareholders call directors to account by legal action. This seems probable; however, even if directors do accept liability, they are still faced with the dilemma of how to prevent failure or how to remediate a project that is in the process of failing.

In order to do this there are a number of disciplines that are required.

In considering these disciplines I ask you to consider that *engineers do NOT design bridges to stand up, they design them NOT to fall down.*

There is a fundamental difference in thinking and approach.

Think about it, when you studied engineering did they ever tell you to conduct 'roadshows' to persuade the public that your engineering structures would perform to specification?

No! It was instilled in you that you would apply the art and science of engineering, working in partnership with other highly qualified and highly experienced engineers who understood the factors that could cause failure and how to prevent failure, thereby ensuring a successful outcome.

From consideration of my own professional training and experience and thinking back on the books and articles that I read as I studied engineering, I have concluded that any field of human endeavour that involves the conceptualisation of a desired future state and then the analysis, design and execution of a solution to achieve that desired state is at some level an engineering endeavour. In fact, surely that is what engineering is all about? – creating new things based on past learning and experience within a highly disciplined framework that we intuitively embrace in our quest to create solutions that work.

Yet ...

- Where is the formal engineering profession in the application of computer-based business information systems?
- Where is the professional accountability?
- Where is the fundamental drive to produce outcomes that meet or exceed expectations?

And so I conclude that the occupation of designing and implementing business information systems is the orphan of the engineering profession.

Somehow many practitioners seem to think that business information systems design and implementation is primarily the domain of some other profession or occupation or do they just think they don't know anything about business information system solutions?

I am really not sure why the formal engineering profession is so silent in the face of dramatic engineering disasters in

business systems, I think all the above factors play a role – what do you think?

Have you ever considered the possibility that the engineering profession should be playing a more direct and active role in the field of business information systems?

If not, what would it take for you to take a stand to support a move to bring this field of human endeavour under the umbrella of the regulated engineering profession?

On what basis do I say this?

THE ATTRIBUTES OF AN ENGINEERING APPROACH

In conducting the work that has been my principal endeavour over the last eighteen years, I have concluded that the principal characteristics of an 'engineering approach' to the application of computers in business comprises the following seven attributes:

- 1 Meticulous design detail
- 2 Meticulous planning detail and costing
- 3 Multi-disciplinary teams and specialists
- 4 High professional standards and legal accountability
- 5 Cross checking and double checking of all important detail
- 6 Physical world metaphor and impact analysis
- 7 Engineers knowing the limitations of their expertise and when to call in specialists

Barring point 6, you may find that the other points all ring true in your own professional endeavours.

Most of these items need no explanation, However, I would like to elaborate on a few of them.

I think that point 4 stands on its own, there is simply no professional body that is regulating the business application of computerised systems and there is no statutory provision for accountability.

It is time that somebody did something about this. The question is, is there a professional body out there that is willing and able to step up to the plate and bat on this thorny topic?

It is my passionate belief that only the body of registered professional engineers has the credentials to do this.

Regarding point 6, the physical world metaphor – I mentioned previously that perhaps engineers think they do not understand computerised business systems

and therefore they believe that some other occupation is better qualified to regulate and control the industry. The problem is, I do not think that there is another body of professionals who have the track record in delivering large project-based solutions with a high record of successful outcomes.

I have repeatedly found that, drawing on my passion for engineering in all its facets, I constantly find physical world metaphors and parallels that make situations easier to understand and more practical to solve.

For example, consider the parallel that a large integrated business information system is similar to a large integrated factory in whatever line of endeavour is most readily understood by the business.

Consider that the amount of professional time that goes into a large business information system is as great as or greater than that which goes into the design and supervision of construction of an extremely large office tower.

Consider that the amount of profes-

sional time that lies behind everything that resides on the average personal computer that you take for granted in your everyday life represents more professional time than has been deployed in anything but the very largest engineering projects that have ever been undertaken.

And then, consider what you, as a practising engineer, would do if you were asked to do something to reduce the level of defects and reduce the level of outright failure in something as complex as this.

Having done this, I challenge you to tell me that this is not an engineering problem of enormous magnitude that I suspect at some level will excite the spark of engineering genius that resides in each and every person who reads this publication.

What do you think the engineering profession could and should do in order to reduce the level of business information system failure and increase the frequency of reliable outcomes?

What do you think the engineering profession could and should do in order to reduce the level of business information system failure and increase the frequency of reliable outcomes?

Write to James at

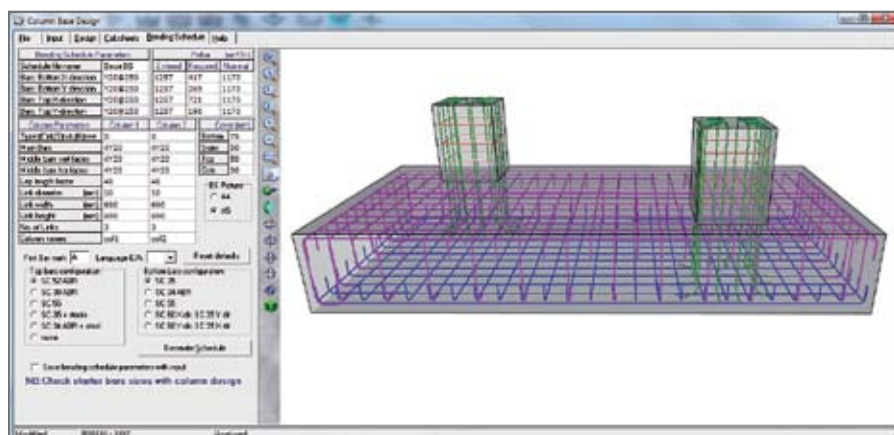
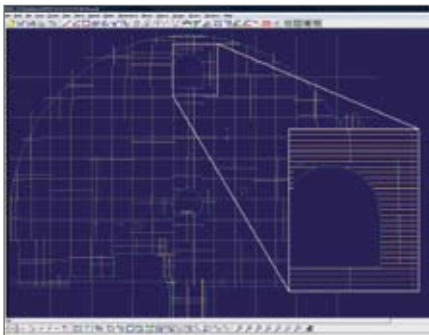
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Prokon

AS THE DEMAND for structural designs increases, Prokon gives the engineer more tools to complete the job with more efficiency and on time! During the course of 2007 the Prokon design team has added numerous functionalities to various modules in the Prokon suite.

For several years the module Frame had a hidden tool: graphical FEM modelling. With the addition of OpenGL technology, Frame's modelling capabilities were dusted off and given a major facelift. Features such as moving nodes with the mouse, under-laying CAD drawings in the work-plane, advanced shell generation, shell splitting and beam generation were added.

A new meshing engine, VENIM, is bound to bridge the gap between Frame and platform based 3D modelling software such as Autodesk's Revit Structure. With the latest in Meshing theory and mathematics, VENIM succeeds in meshing complex polygon shapes into well spaced quadrilaterals with excellent dimension and angular aspect ratios within seconds.



At long last the consolidation process of all Prokon FEM modules into one super software machine is complete. With rotated supports, point loads within shell elements, reinforcement contour exporting to PADDs and full file format compatibility, Frame can now support all the functionality of the old Finite element slab design module (FESD).

New links from Frame to other Prokon modules have been added. Wind loading calculation is a breeze with a link from the portal frame input wizard to the wind module. The additional steel design links to the cleat connection design modules have also been implemented.

Frame has also grown in mathematical wisdom! The analysis engine will point any isolated piece of your structure out to you graphically. Frame will evaluate your meshing skills with a mesh indication factor and show you where your mesh needs improvement. Additions have been made to the Modal/Seismic analysis domains such as mass participation factors and the CQC (Complete Quadratic Combination) method (which looks at the cross correlation between mode shapes) as an alternative to the SRSS method. Graphics improvements to some of the concrete modules will give engineers a better perspective with regards to detailing. In addition to added bar manipulation functionality in Continuous Beam, this module, as well as Base, Rectangular and Circular Column design now boasts full 3d previews of reinforcement configurations.

Generating slab reinforcement is as easy as the click of a button with the new Area Zone detailing function in PADDs. The new group expansion preview gives the user insight into complicated and intricate rebar mat layouts.

The compatibility of PADDs with AutoCAD has been updated with new import/export technology which can read and write the latest AutoCAD formats.

ProdoX

In the past few years our customers have indicated that they have a need for a document management tool in the construction industry. ProdoX has answered their needs. This product has certain unique methods of dealing with the important, but often neglected function of dealing with all the administrative paperwork associated with a project. The product was developed in conjunction with several consultancies, large and small, resulting in a practical, easy to use, yet powerful product. Some features include: easy sharing of data and contact lists, support for incoming and outgoing documentation, global, project based and user based settings, support for print, e-mail (local or default client), FTP, and web based transmittals, phasing in projects, reporting directly or exporting to spreadsheets, etc. ProdoX is being used by several customers and the user base is expanding very fast.

ProDESK

ProDESK is Prokon's "link" to Autodesk's award winning Revit Structure. Revit Structure allows the user to liaise directly with architectural models or to model anything directly. ProDESK provides the user with a bi-directional link between this model and the Prokon analysis tools. A consistent structural section database between the two allows for easy modelling, export and reimport functionality. Automatic meshing of plate structures (with optional user intervention and changes), speeds up the modelling and design process. This product is consistently under development and new versions are supplied with every release or service pack of the Autodesk. ■

Software methodologies that meet service delivery

AWARD-WINNING PROJECTS that demonstrate excellence in their quality of development, delivery and sustainability often gain high profile in media and press releases, but the IT systems, software development tools and development processes that underlie these projects are often overshadowed by the more visible end results.

The tools and techniques behind the scenes are numerous and difficult to quantify. Broadly speaking, a measurement of the effectiveness of practical software and IT systems in engineering projects include a rationale relating to the nature of the task at hand and the efficiency with which data can be captured, analysed and integrated into the final design. Infrastructure design software tools fall under the spotlight as to their effectiveness in producing the required results while increasing productivity at the same time.

Quality standards associated with the development, supply and maintenance of software are increasingly incorporating client centred performance measurement criteria in assessing the standard of software delivery. The ISO 9001 standard for this category is defined in terms of 'the totality of features and characteristics of a product or service that bear on its ability to satisfy specified or implied needs'.

Knowledge Base – the developers of the Civil Designer suite of infrastructure design software – have set out to implement progressive and best practice techniques in their software development methodology. Their unique Spiral Development Model places the user at its centre with regular feedback loops before and after each process in a continuous spiral.

The spiral consists of several cycles which incorporate the Requirements, Specification, Design, Development and

Acceptance testing. Each cycle ends in a review meeting with project stakeholders who decide if they would like to continue with the next cycle or perform corrective action by re-entering the previous cycle.

The Development cycle is an iterative process based on the agile development methodology. Each iteration results in a complete program fragment after a set 'sprint' of development activity and entails design, development, testing and documentation of the program fragment which once again ends with a review meeting.

To ensure optimal software quality a five-tier quality assurance process is woven throughout the spiral, verifying software quality from the lowest level (Component testing) within the development sprints, Integration Testing, Acceptance Testing and the highest level (Beta testing) by selected clients in the field. The fifth element of the process is Regression testing, which ensures that fixed defects are not being re-introduced into the system.

According to Knowledge Base Software Development Team Manager Dawid du Toit, the system has been successfully implemented and has already started to yield positive results.

Client requests for enhancements or new features are recorded in a database. As far as possible, requirement descriptions are kept as close as possible to the original request of the client. Requests are then spilt into various priority levels for action.

According to Dawid, the software process allows developers to pinpoint the exact needs of the client. 'At review meetings the team receive important feedback from various internal stakeholders who are responsible for channelling client requests and feedback through the system. Review meetings during the development cycle

allow greater visibility into the development process which in turn reduces risks and increases confidence. This means that clients can be kept informed more accurately regarding current developments,' he explains.

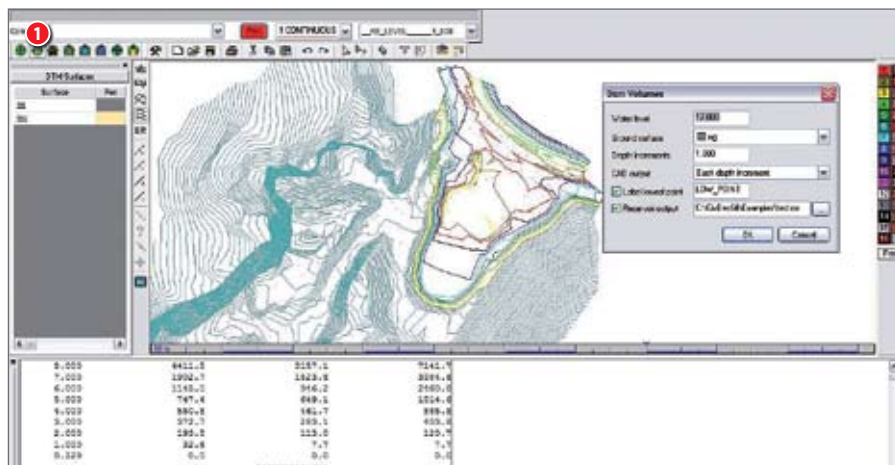
In addition to the fundamental feedback via testing cycles, Knowledge Base implements three levels of client input. These levels include a troubleshooting call centre, an interactive discussion forum as well as client user group sessions. The uniqueness of the Knowledge Base development model lies in the integration of these three tiers which allow the user to play a proactive role in the design of the software.

Client input has shaped the software design in three significant ways – these include time saving, cost saving and the user intuitiveness of the product.

FASTER THROUGHPUT

The need for time-saving measures resulting from increased infrastructure development initiatives currently under way has become a significant priority for most consultancy firms. This theme has become apparent through the interactive client discussion forums and user group sessions. This has led to a number of innovative additions to the software.

'The means to instantaneously switch between plan view, long section and cross sections with sheet file customisation options is the sort of functionality which is eliminating the need for CAD work altogether and resulting in faster and efficient delivery. In addition, it is now possible to generate final drawings from an initial design so that all the contours and design elements are converted to CAD elements with a couple of clicks. This makes all the difference to a designer,' explains Software Support Manager Brett Pureveen.



① Civil Designer's Auxiliary Lanes Function includes a 'Speed Profiles' tool which calculates the point on an ascent at which a climbing lane should be positioned

② The Dam Volumes function in Civil Designer's Survey & Terrain module creates a reservoir file which can be used directly in the reservoir routine in the Stormwater Module. The data can then be used to calculate the depth and storage arrays for detention pond storage volumes

where existing or new pipes cross the road so that the route can be adjusted.

CAPACITY BUILDING

Time, cost and user interface advantages are frequently at the forefront of the engineers concern during the execution of a given project. The quality and effectiveness of project delivery however, must include a fourth perhaps more significant measure: capacity building.

The inclusion of a training arm in the development process not only keeps the software in touch with new and emerging engineers, but also provides the vital connection between industry and education.

With the introduction of the new National Curriculum Statement (NCS) by the Department of Education, Knowledge Base has supported the process with free educational software. Technology is playing an increasingly important role in today's engineering curriculum and software partnerships like this are having a huge impact on curriculum execution. The software's influence therefore goes beyond its distribution and development.

BEST PRACTICE AWARDS

Best practice methodologies and standards provide a solid foundation for the successful future of civil engineering in South Africa. It is for this reason that software excellence awards will begin to play a vital role in increasing the innovation and quality of infrastructure design programs and their development techniques.

The South African Institution of Civil Engineering (SAICE) has recently discussed the possibility of including an awards category in infrastructure software design in an attempt to acknowledge the tools (software) that allow civil engineers to meet their service delivery deadlines.

Future award programs are likely to be more holistic in nature encompassing the elements of time, cost, user intuitiveness and capacity building in their measures. ■



According to Knowledge Base CEO Vincent Bester, the software handles up to 10 million DTM points and up to 2 GB bitmaps and produces complete drawings ready for plotting. 'Designs are completely configurable according to each individual requirement. This alone saves hours of CAD time as the drawings can be generated with all the notes, titles, and other details required for output,' explains Bester.

Owing to the increasing amount of water infrastructure design projects in South Africa, there has also been an emphasis on including time saving enhancements within Civil Designer's Water module. The program now allows you to establish total demand in a network using a number of people and per capita demand. Civil Designer will automatically assign demands for each node proportionally to the lengths of the adjoining pipes.

COST SAVING

In addition to the cost-saving measures associated with production time, effective systems and IT tools can also eliminate the need for additional analysis software and expert consultancy. Civil Designer reduces costly delays via a number of comprehensive analysis features.

The dynamic earthwork design, TRH design criteria built into the Roads module,

a kerb library, auxiliary lane routine, regression analysis and rendered 3D drives all contribute to the self-sufficiency with which a project can be executed and completed.

USER INTUITIVENESS

Client interaction has also led to the evolution of the Civil Designer user interface which allows integration across various design modules on a seamless platform. Information about pipe services contained in multiple databases, for example, can be accessed from the Roads module Pipe menu. Users can add a database, remove a database from a list and also edit the database settings such as the database name and file path. ASCII data and drawing entities can be imported into a Pipe Database spreadsheet.

Information in these databases can then be used to indicate crossing positions of the pipes/cables on the Road, Sewer, Storm and Water Long Sections as well as the Road Vertical Alignment view. These databases can also be used when running the Pipe Clashes routine.

In addition, the program interactively indicates other services and service clashes when designing a road. This means that when the designer is defining for example the road long section (or vertical alignment), the designer will be shown exactly



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HARBOUR ENGINEERING

The fishing harbours of the A study in extinction

THE WATERS OFF South Africa are rich in fish, yet it has the straightest coastline in the world with the least amount of natural protection and is exposed to very high wave energy. This is best illustrated by the problem of measuring the length of the coastline.

The only practical way to measure the length of a coastline is to step it off on a map with a pair of dividers. The length measured this way will vary according to the step length to which the dividers are set and the natural irregularity of the coast. A log-log plot of the step length versus the total length measured will generally produce a monotonically declining straight line curve, the negative slope, m , being a measure of the irregularity of the coast. The fractal index is usually quoted as $1-m$ to give a positive number greater than 1. The value for the South African coast is 1,048 and is anomalously low by world standards.

Three coastlines were included in figure 1, those of South Africa, Australia and the West Coast of Britain. The length of the South African coastline is 3 551 km at a 50 m step length. This is very short compared to the generally quoted figure of 15 000 km for the coastlines of both Australia and Britain. This form of presentation is very effective in showing up the tremendous anomaly of the South African coast and gives a quantitative measure to the intuitive experience of South African coastal engineers that there is something peculiar about our coast that makes it particularly inhospitable and harbour building particularly difficult.

Physically, irregularity in a coastline stems from headlands and embayments, peninsulas, fjords, lagoons and other such features. These all have the effect of intercepting and attenuating oceanic storm waves and providing sheltered water, reducing the cost of protective works at any harbour in these waters. Saldanha Bay is the only example in South Africa of a natural harbour formed by gross indentation of the coast.

Durban and Richards Bay are examples of another aspect of our lack of coastal irregularity. Here potential irregularity has been smothered by coastal processes and expensive training works and sand bypass dredging are required to provide access across the coastline to the harbours.

Much of the South African coast can be described as either straight, wall-like, rock-bound coast or shallow, crenulate bays where the embayment behind rocky headlands has been largely filled by coastal sediments in classic half-heart bays. Prograding, sand-bound coasts – but still essentially straight – exist north of Durban and Luderitz. Only in the Western Cape does the coastline exhibit a more normal degree of indentation. By and large, harbours in South Africa must be built straight off the coast into the full force of the oceanic seas.

This peculiar nature of the African shores was noticed as early as 1776 by Adam Smith when he wrote: 'There are in Africa none of those great inlets, such as the Baltic and the Mediterranean seas in Europe ... to carry maritime com-

merce into the interior parts of that great continent.'

The Gilchrist Report of 1927 put it this way:

Throughout this coast line two features stand out. One, the general absence of deep embayments, navigable estuaries or sheltered inlets of considerable area; and second, the small number of rivers of large volume readily accessible from the sea. The southern portion of the Continent is projected into an ocean area at times characterised by violent winds and heavy seas.

The seas off the coast of South Africa are largely the result of frontal storms in the Southern Ocean and the South Atlantic, although the Natal coast is exposed to the occasional effects of Indian Ocean cyclones. Wave energy reaches a maximum off the Cape Peninsula with a ten-year deepwater significant wave height of about 10 m and a maximum wave height of about 18 m. Breakers of 20 m have been claimed for the Dungeons reef off Hout Bay and I have estimated similar heights by tachy for breakers on the blinders off Oudeschip. Northwards this wave energy declines to about 5,5 m at Richards Bay and 4,5 m at Walvis Bay. Almost the entire South African coast is best described as a 'high-energy shore'.

In earlier times this character of the South African coast prevented the development of an indigenous fishing culture and led instead to a beachcombing/hunter-gatherer way of life on the coast.

Modern thinking is tending to the

Western Cape

view that it was this beachcombing culture, trapped in the narrow coastal belt of the Western Cape between the sea and the mountains and interior deserts, that drove the evolution of modern humans from *Homo erectus*.

On the gently sloping shores around Cape Agulhas, where the shoals of the Agulhas Banks reduce the wave energy, the early hunter-gatherer inhabitants built fish traps of handstone boulders to trap reef fish on the tides. On the West Coast there are clear archeological signs that crayfish were eaten regularly by the shore-dwelling people. None of these people, however, used any form of boat or water craft. It was the early European settlers who first introduced boats to these shores.

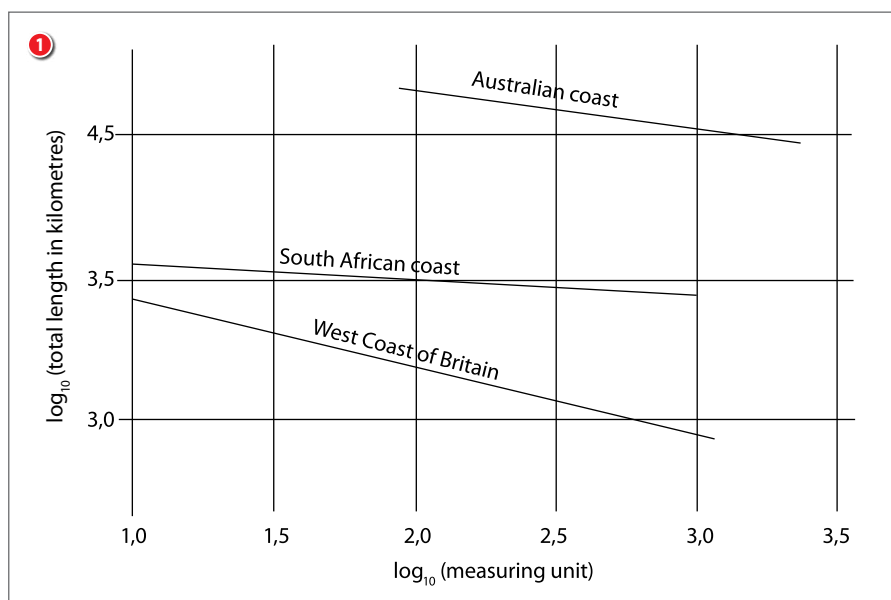
The arrival of the Dutch and the Malays some 350 years ago did nothing

to change this, despite the maritime backgrounds of these groups. It was only some 150 years ago, under British administration, that the coast was opened up to fishing. From that start, the industry grew slowly.

The West Coast of South Africa – west of Cape Agulhas – is a cold water shore. In summer the south-east trade winds induce an upwell of cold water against the shoreline. It is this cold, nutrient rich bottom water that makes the Southeast Atlantic one of the world's great fisheries. In its pristine condition, the continental shelf sustained rich demersal and pelagic fisheries and extensive stocks of crayfish. There are also extensive line fish, tuna and squid fisheries off the South Coast of South Africa.

In 1896 the Cape government brought

- ❶ Comparison of fractal indices (degree of irregularity) of coastlines
- ❷ Skull of Hopefield Man – about 500 000 before the present
- ❸ The footprints of 'Eve' in the sandstone of a fossil dune at Langebaan Lagoon have been dated to approximately 117 000 years before the present



out Dr John Gilchrist to start the Marine Biological Survey and the following year acquired the steam trawler *Pieter Faure* to survey the fisheries potential of the Cape waters. By that time, refrigeration made it possible to transport fresh fish by rail and market it in the growing centres in the interior. The demersal fishery grew slowly but steadily from this start to the present levels.

In 1890 the American schooner *Alice* used a purse seine net to catch pelagic fish off the Cape. Although successful, the venture was not economically viable. It was not until the 1940s that the pelagic industry really started. Initially, this fishery grew very rapidly, but since the late 1960s it has been stable.

The canning of crayfish tails for export also began shortly after 1900 at a number of sites on the West Coast. The catch grew steadily and peaked at about 15 000 tonnes per annum in the early 1950s. Thereafter there has been a slow decline to present levels of about 1 500 tonnes per annum.

In general the South African fisheries have been reasonably well managed by world standards and seem to be stable.

In 1926/27 Gilchrist was appointed to lead the Gilchrist Commission to investigate sites for harbours for an inshore fishery and accommodation for larger vessels in the commercial ports. It led directly to the establishment of the modern South African fishing industry but it contained a fundamental flaw. It only surveyed the coast and made no recommendations for the structure of the industry or administration of the fishing harbours.

In 1928 the Department of Sea Fisheries – precursor to the present state fisheries department, Marine and Coastal Management, MCM – was created. One of their responsibilities was the provision and administration of fishing harbours. After a brief attempt at undertaking this themselves, they asked first the Department of Public Works (PWD) and then the national railways and harbours administration (SAR&H) to provide tech-

nical services for the fishing harbours.

In 1944 the Fisheries Development Corporation (FDC) was formed to develop the fishing industry, which it did most successfully. Thereafter growth of the industry, particularly the pelagic sector, was rapid, leading to a concomitant demand for harbours. The SAR&H were unwilling to upgrade their technical services to accommodate this rapid growth, so the FDC were asked to take over the function, which they did in 1963 when they opened a full engineering office and maintenance unit. Piet Grobbelaar and his draughtsman, Jack Badham-Thornhill, who, between them, had been running the Fishing Harbour office of SAR&H, were seconded to FDC to set up and then run this department. They immediately set about developing the present suite of fishing harbours – ten harbours (at that time including the fishing harbour at Walvis Bay) and five landing places – all of them sites where there had been some prior development.

THE HARBOURS

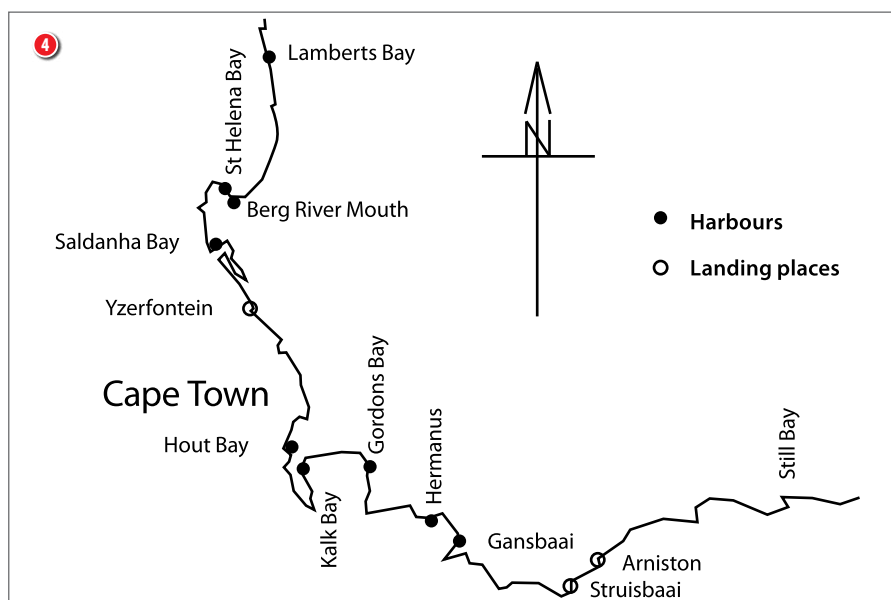
Bits and pieces of work were done all around the Cape coast as far back as the beginning of the 20th century to assist local fishing communities. Although most of these works were of insignificant scope, they served to entrench local fisheries at those sites and create focal points for subsequent small harbour construction.

Cape Metropolitan Council

Hout Bay is the flagship of the fishing harbours. It is one of the oldest and largest of these harbours and arguably the most picturesque. It got its start in 1903 when a Frenchman, Lucien Plessis, fitted out the hulk of an old wooden sailing ship, the *R Morrow*, and beached it in the protected end of the bay below the Sentinel at what is now the site of the SA Sea Products factory. This hulk served as both landing quay and canning factory for the early crayfish fishery. There was a slow growth

Table 1 List of proclaimed fishing harbours and landing places

Harbours	Landing places
Walvis Bay (Cannery Row) (transferred to Namport)	Yzerfontein (transferred to local authority)
Lamberts Bay	Kommetjie
Berg River Mouth	Kleinmond
St Helena Bay	Hawston
Saldanha Bay	Van Dyks Bay
Hout Bay	Arniston
Kalk Bay	Struisbaai
Gordons Bay	Still Bay
Hermanus	
Gansbaai	



4 Location of fishing harbours and landing places

5 Hulk of *R Morrow* – origin of Hout Bay Harbour

6 Hout Bay. The *R Morrow* lies under the quays at the bottom of the photo

7 Kalk Bay

8 Gordons Bay – The naval harbour is to the right, the public harbour to the left

9 Yzerfontein

from this early start. The first 200 m of breakwater was built in 1937, but the bulk of the present harbour was built in the late 1960s by the FDC in response to the boom in the pelagic fishery.

The FDC acquired a 200 mm cutter suction dredger, *Solen*, on this project to do the dredging of the harbour and to reclaim a strip of usable land around the periphery of the water. So began a long, hard process of learning about dredging.

Hout Bay was one of the first South African harbours and certainly the first fishing harbour to get a full-blown floating yacht marina. This marina was designed and built by mechanical engineers familiar with both fishing vessels and fishing harbours and is probably by far the best designed marina in South Africa. A second marina was built for motor yachts around 1990. This was a copy of the concrete marina built at the Durban Point Yacht Club a few years earlier and widely published. Although the Durban marina gave good service, the Hout Bay marina started to fail by corrosion as soon as it was installed.

I like to blame this on B G Callaghan.

In his extensive study of atmospheric corrosion in southern Africa, he comments on Durban that 'Durban can be expected to be highly corrosive', corroborated by his data from the Bluff test site. Unfortunately his report is not clear on the location and I only got the details when I asked him. It was on the seaward side of the bluff within the splash zone of the surf! Corrosion levels in Hout Bay when the Southeaster pumps across the bay are not much different. By contrast, compared to these high levels, corrosion levels at the Point Yacht Club are relatively benign and give a false impression of the durability of concrete marinas.

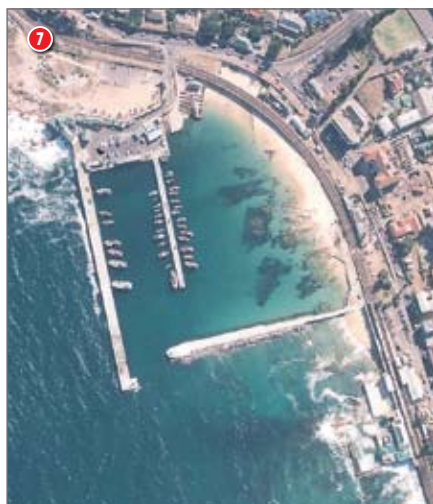
Kalk Bay Harbour was built in 1919 to serve an existing fishing community. It is the only fishing harbour to be built of dressed stone. The previous 30 years had seen two major construction projects in Cape Town done in dressed stone – Table Mountain reservoirs and the Simonstown Naval Dockyard – so that plenty of stone masons were available.

Gordons Bay grew slowly through the 19th and early 20th centuries as a seaside holiday village. The present harbour was

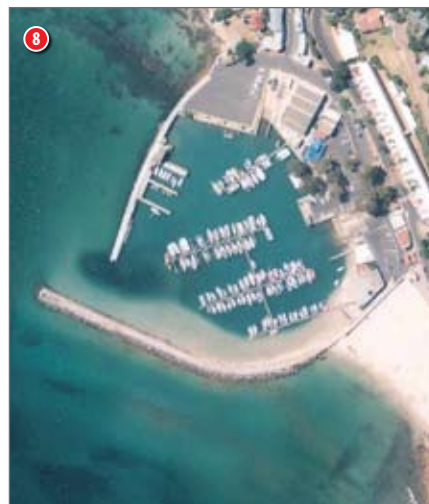
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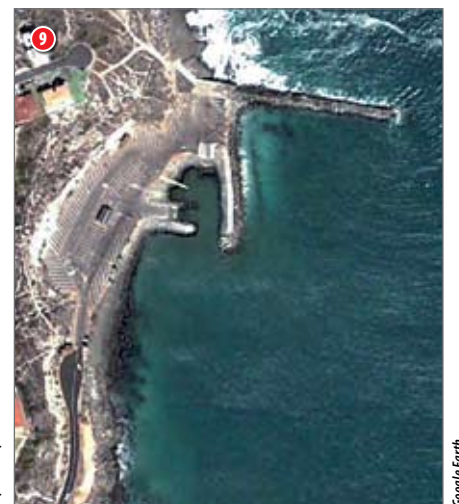
Cape Metropolitan Council



Cape Metropolitan Council



Cape Metropolitan Council



Google Earth

completed in 1939 in substantially its present form as a fishing harbour. During WWII one side of the harbour was taken over by the SAAF as a crash boat station. In 1948 the South African Merchant Navy College General Botha moved there when they left Simonstown. In 1958 that side of the harbour was transferred to the South African Navy.

During the second half of the 20th century fishing at this harbour ceased almost entirely, the harbour filling with recreational vessels. The harbour remained a proclaimed landing place, however, and with the change to a large number of small fishing quotas, fished by small operators, fish are again being landed at the harbour.

The construction of the harbour created a sand trap on the south side that has grown to a respectable beach known as 'Bikini Beach'. Unfortunately, the breakwater was built of rectangular concrete blocks only and is completely porous to this sand, so that the harbour has to be dredged regularly.

The proclaimed fishing harbours within the Cape Town metropolitan area are all in the process of changing their function from commercial fishing to recreation. At Gordons Bay, the change has been almost complete for many years. Kalk Bay, surprisingly, still serves the original artisanal fishing community for which it was built, and this tends to limit the recreational use of the harbour. Hout Bay is large enough to be shared. It has a large and diverse industrial fishery which is undiminished in size while large-scale recreational boating and tourism are establishing themselves in the harbour.

West Coast

Yzerfontein (not Ysterfontein) harbour was originally built as a private fishing harbour. The contractor was Murray & Stewart and this project was the late Des Baker's first big job. The fishing company that commissioned the harbour failed soon after its completion and the place was abandoned, but the work that had been done was sufficient to make a potential landing place of it and so it developed like most of the others on this coast. A proper launching ramp was built by the FDC in 1980 and later the whole facility was handed over to the Yzerfontein local council.

The place is also notable for its contribution to conflict resolution. There is

always some conflict between the interests of the fishermen and residents. At Yzerfontein this has been resolved by limiting activity in the harbour to launching and landing only and by establishing a marshalling area outside town for all other activities such as sale of tickets for launching, sale of fish and cleaning of boats.

Saldanha Bay, as a harbour, is as old as Table Bay. In the early 20th century, a landing stage was formed, as in Hout Bay, when the hulk of the *Präsident* was beached in Hoetjies Bay at the site of the present Naval Base – now known as the 'President Jetty'. The provision of significant infrastructure only started during WWII as a staging for convoys. The main harbour work was what came to be known as the 'Government Jetty', also in Hoedjies Bay. This is a reinforced concrete structure and supposedly was built using sea sand and sea water for the concrete. (I think the most scared I have ever been was back in 1974 when I was asked to make a jetty inspection of this structure. My shipwright, the late James Kasner, rowed me in under the jetty and we stayed just long enough to get a good impression of the extent of the corrosion of the reinforcement then I told him to 'get the hell out' before the structure collapsed!)

Surprisingly, like the Swakopmund jetty, this one is still standing. In fact it was reinforced by the addition of a new upper deck shortly after this for fitting out caissons for the construction of the Sishen ore loading terminal. The FDC contribution to Saldanha Bay was a long quay, now occupied by Sea Harvest, adjacent to the government jetty, a 1 200 tonne slipway and leading jetty, and a small craft facility in Pepper Bay.

Strictly speaking the name St Helena Bay applies to the whole sweep of coast inside Cape Columbine and contains two fishing harbours – one at Sandy Point now generally known as 'St Helena Bay' and the other at the Berg River Mouth sometimes known as 'Laaiplek', although strictly 'Berg River Mouth' covers both Laaiplek and Velddrift, which are both on the river. The marina township of Port Owen lies on the river between these two places. The bay is also home to two private fishing harbours. Stompneus, in the lee of Cape Columbine, is a natural harbour not needing any artificial protection and West Point, is an artificial harbour at the entrance to Slipper Bay, a very protected

part of the bay.

Originally the Berg River ran along behind the back-beach dunes for a kilometre or so before breaking through to the sea in a very shallow, changeable mouth. A new mouth was created by cutting through the dunes some way upstream where the rock bed was deeper and entraining the mouth with pre-stressed concrete sheet pile walls for some distance out to sea. The result allowed the larger pelagic fishing vessels entry into the river to the fish factory. The use of sheet piles for the training walls looked good on paper, but in practice there were areas where the pile driving was poor. In some places the fill behind the piles leached out under wave action and in others the piles settled into the sea bed.

Two fish factories had already established themselves at Sandy Point when the FDC built the breakwater to create St Helena Bay harbour. Besides a new slipway, the improvements included a boat ramp, public jetty and small craft quay. Bill Robinson and I cut our teeth in marine work on this latter project. It was the first marine project I designed and the first that Bill built.

Lamberts Bay is the northernmost of the proclaimed fishing harbours. Here Penguin Island lies about 100 m offshore and forms a partially protected dog-leg channel between the mainland and the island. This island was worked for guano in the 1840s and scraped ever since, making this site much older than the others. The harbour was created by a closing wall at the southern, seaward end of the channel between the island and the mainland and subsequently expanded by another breakwater off the lee side of the island to create an inner and an outer basin. A temporary bridge was constructed over the lee entrance to the channel to gain access to the island to build this second breakwater. The island itself is managed today as a bird sanctuary and tourist attraction.

Lamberts Bay played an active role in the Anglo-Boer War when the Royal Navy stationed a vessel there to prevent German gun runners landing munitions for the Boers on the West Coast. The vessel was subsequently wrecked when it ran aground just south of the harbour in thick fog.

This harbour suffers from silting. The original construction of the closing wall left flushing ports in the wall. Although the water looks clear, it still contains

some suspended sediment, so these ports only serve to import silt to the inner basin. The effect of the main breakwater is to create a headland that 'wants' a crenulated bay. The east mole was built to block the flow of sand across the entrance channel to the inner harbour, but once this embayment filled, the sand overtoped and silted up the channel. This harbour needs routine dredging.

Once the dredging and reclamation work had been completed at Hout Bay, the dredger was moved to Berg River Mouth to maintain the depth in the channel and on occasion moved to Lamberts Bay to do maintenance dredging in that harbour.

South Coast

The village of Hermanus, like Gordons Bay, grew in the late 19th century, initially as a fishing village. At one point a natural rock ramp was used as a landing place for fishermen. The village is built on the top of a long line of sea cliffs with deep water below. These cliffs attracted anglers and the village grew to a seaside holiday village. Today these same cliffs and deep water provide excellent whale watching, renewing the attraction of the place now that the inshore fish stocks are so depleted.

With the growth of the village, boating off the ramp increased and some improvements were made. However, the environment on that shore is so hostile to harbour construction that there was no attempt to build a harbour at the site of the original landing place.

There is a local tradition that the new, fancy residents objected to smelly fishing activities at the old harbour, but I find that unlikely. A different site was sought for the 'new' harbour. Only a main breakwater was built at the new harbour and conditions inside the harbour are 'a bit on the bouncy side'. A secondary closing wall is needed to complete this harbour.

The wall was built during WWII from rectangular concrete blocks on the edge of an underwater gully. The wall has to be constantly 'fed' to replace blocks that are rolled into the gully by the sea. Thirteen-tonne *toskane* blocks used to be used for this. The harbour precinct is home to a number of fish-processing plants, as well as a *perlemoen* (abalone) hatchery and farm.

The village of Gansbaai grew up around a natural landing place for dinghies. The harbour grew out of a sequence

of improvements to this landing place starting with the old Cape colonial government. In fact, this is a most unsuitable site for a harbour. It that suffers from a wave-focusing offshore reef – a problem that was not apparent until the breakwaters were built. As a result the design of the 'new' outer breakwater with 17-tonne dolosse proved to be inadequate and had to be rebuilt with 25-tonne dolosse. There is a far better site a few kilometres along the coast at Roman Bay where the harbour should have been built. Even allowing for the cost of road construction and of moving the fish factory, the costs may well have been less than the total amount spent on the present site. As a result of the wave focuser, the harbour closes during storms, a problem that does not occur at Roman Bay. The original site should never have been developed beyond a landing place.

Although Struisbaai, Arniston, and Still Bay are proclaimed fishing harbours, they are little more than boat ramps, so that I have classified them under landing places in table 1. In the late 1980s Struisbaai was upgraded to mini-harbour by the construction of a small breakwater and some small craft quays.

TECHNOLOGY

The core function of the technical department of the FDC was the design and project management of the construction of marine capital works with the maintenance, survey and research units peripheral to this function. As a result, the operation of the department was very similar to that of a consulting engineering firm, but having a single client: the then Department of Sea Fisheries. The state carried the costs both of running the department and of the projects they implemented and allowed a service fee to the FDC for hosting the department.

The technical department was organised into four sections: Design and Project Management including the Drawing Office; Hydrographic and Cadastral Survey; Research and Model Testing; and Maintenance and Small Works.

It was the time when modern coastal and harbour engineering was just being established. The FDC found themselves attempting to build small harbours on an exposed, high-energy coast and a highly corrosive, arid shore with little prior guidance. As was to be expected, the learning curve was steep. Considerable pragmatic

experience was gained that integrated well with the mainstream advances in the science.

The 1950s saw the development of the Hudson formula and the French invention of the first artificial concrete breakwater armour block, the tetrapod. At the time, Eric Merrifield and Piet Grobbelaar were young engineers together in the Table Bay Harbour office and got to discuss this new invention and, in particular, the potential of the form of the admiralty pattern anchor for an armour block. Later, Eric went off to East London where he converted this idea into the dolos. The rest is history. Piet went off to the fishing harbours and developed the idea into the 'toskane', a name he once told me, came from the Etruscan word for anchor. The early fishing harbour breakwaters built under the SAR&H were of rectangular concrete blocks and he maintained that his *toskane* design fitted these blocks better than other designs when used as an outer armouring and reinforcement.

A modified rectangular block was also developed in the FDC office and named the 'Grobbelaar' block. Both blocks were listed in the CERC Shore Protection Manual, now the Coastal Engineering Manual. By and large the *toskane* block in sizes of 4, 8 and 13 tonnes was used for repair and armouring of older walls with rectangular block cores and dolos in sizes up to 25 tonnes were used for new works as armouring on rubble mound structures.

Sources of rock for rubble mound structures or for the armouring of revetments is always a major factor in harbour works. Although back in the 1970s and early 1980s modern environmental awareness was just starting and environmental legislation was non-existent, the requirements of the Department of Mineral and Energy Affairs were very stringent in this regard. An archaeological clearance certificate was required if there were any signs of cultural remains. Given the long lead times in identifying and getting approval for a quarry, this must be started by the engineers at the inception of the project and an approved site handed over to the contractor when he moves onto site. Finding suitable rock can be a problem. Breakwaters need large rock. Quartzite in particular tends to shatter and quarrymen in general are trained to fragment since most rock used in normal construction is crushed stone.

On one occasion I was invited to an archaeological talk that turned out to feature two rock outcrops, one of which I had blown up shortly before to extend the breakwater at Lamberts Bay. On another occasion some years later a TV programme on South African ghost stories featured this same quarry. Apparently the quarry operations disturbed the spirits and they made off with a cow and a donkey! The contractor was not amused when he learned what had happened to the donkey and cow for which he had had to pay!

From the beginning, corrosion was recognised as a problem, particularly the corrosion of reinforcement in concrete. In the early days only BSCP 144 and BSCP 2007 were available for concrete design – the latter was used for crack control and all faces were treated as wet faces. Minimum cover was 50 mm.

In the late 1960s the cement factory at Piketberg began production of ‘Cemarine’ pozzolanic cements, and these were used for all marine structures during the early 1970s. By the mid-1970s this cement had become much more expensive than OPC and its use was discontinued.

Generally in those days mixes were specified as a minimum of eight pockets per cubic yard with a strength of 3 500 psi (25 MPa). (The fishing harbours were only metricated after the start of the Walvis Bay Syncrolift became operational in 1972. The American equipment and drawings were all imperial and it was felt better to delay change-over and keep the structures imperial to avoid confusion.) Today we know that these strengths are grossly inadequate for marine concrete – a strength of 45 MPa is more appropriate

– but in those days strengths of 3 500 psi were considered high for plain, heavy scantling reinforced concrete. Within a lifespan of 30 years, these structures have all been severely compromised by corrosion of the reinforcement, although usable life can continue for many more years.

Steel sheet piling was not used in the fishing harbours, so normally recognised accelerated low water corrosion – ALWC – did not manifest itself in the harbour structures. A novel form, however, was first identified in South African fishing harbours in slipway rails and appears to be common to slipways worldwide, although it has not yet been recognised in international studies of the phenomenon.

Another observation from the fishing harbours was the behaviour of marine concrete structures with respect to ALWC. The problem has not been observed in marine concrete in the lower tidal zone – the region where it occurs in steel structures. Presumably the permanent saturation of the concrete precludes the pumping of ions through the concrete cover. An equivalently severe form of corrosion, however, does occur in and just above the upper tidal zone in marine reinforced concrete where the alternate wetting and drying and concomitant pumping of ions is particularly severe. It could be termed ‘accelerated high water corrosion’ or AHWL, but has apparently not been formally identified as such in the international field.

In the early 1970s the FDC retained the services of the late Commander Winifred Copenhagen, OBE, one of the pioneers of corrosion science in South Africa, as our corrosion consultant. Subsequently his place was taken by the

late Michael Dawes. With the aid of these two men comprehensive anti-corrosion policies for structural steelwork were put in place. Impressed current cathodic protection systems were developed for slipway rails, including the in-house development of purpose-designed solid state transformer rectifiers and using scrap steel wire rope as longitudinal anodes. An economical heavy-duty coating based on a zinc substrate and SABS alkyd roof paint was developed and proved for structural steelwork both on the quayside and subject to immersion. It outperformed high-performance paint systems under the service conditions that apply in these harbours.

Because of the large number of slipways amongst the fishing harbours, the technology of these became an issue. In those days the technology of dry docking was limited to the empirical. There was no coherent theory of dry docking other than that of the Crandall family in Massachusetts, which they held as proprietary information. The only published information was a few comments by R R Minikin. The FDC set about developing much of this theoretical underpinning of the empirical. The main component of a comprehensive theory still outstanding is that of keel blocks. It is a matter more relevant to graving docks than slipways and hence was not tackled in a comprehensive fashion by the FDC.

A characteristic ‘Cape’ type slipway was developed by the FDC that has become the reference standard in South Africa. The development of the ‘Cape’ type had its origins in the change from timber to steel for the cradle with a precursor in a pair of slipways, one at Hout



Bay, the other at Gansbaai designed by the Fishing Harbour office of the SAR&H in 1948. The FDC improved on these precursors, the prototypes being a set of three identical cradles at Hout Bay, Kalk Bay and Hermanus. They then went on to pioneer the use of manned docking frames on the cradles, hydraulically activated bilge support arms, portable hydraulic cable jacks in capacities of 14, 20 and 40 tonnes, large-diameter wheels with the cradle suspended beneath the axles for maximum draft over the blocks, vertically curved ways, and the method of casting in the dry and incrementally launching the ways structure.

Concrete boat launching ramps can be considered to be the Mickey Mouse end of dry docking. Here again effective methods of construction were pioneered by the FDC: mainly methods of using precast slabs for the underwater and tidal regions of the ramp. These techniques worked well in protected waters inside harbours. However, problems with this type of ramp soon manifest itself on the exposed, high-energy South African coast. On this coast, concrete floats! Some progress was made in understanding the problem, including model testing and improving the energy tolerance of these ramps, although much work remains to be done.

Dredging was another field requiring high levels of expertise. The Dutch are fabulous people to work with, but they don't abide fools. You need to know what you are doing and prepare a project thoroughly before calling in the Dutch dredgers. The blokes at the FDC who handled the purchase of the *Solen* were still green when they gave the contract for the supply of the dredger to a small

operator in Holland. Not only did they get a vessel with antiquated hydraulics and an engine that was made obsolete the year it was installed, but two other unsuccessful tenderers – IHC in Holland and Ellicott in the USA – jointly submitted to complaint to the International Chamber of Commerce in Paris regarding the conduct of the purchase. It took quite a long time to shake down the equipment to an efficient machine.

Twenty years later the expertise at the FDC had changed enormously. In particular notice was taken of the special provisions for dredging in the FIDIC general conditions of contract. The last dredging contract they did was the fishing harbour at Walvis Bay. It involved nearly a million cubic metres – and was completed in about six weeks without any outstanding issues at the end of the contract. This time the response from the contractor was very different:

Without a positive attitude of the Employer in general and the persons involved in such a project in particular, a Contractor is left alone with his problems. Too often we encounter a lack of willingness from the Employer to take problems that inevitably arise during the execution of any project seriously, not so in Walvisbaai.

We therefore consider the smooth execution of the Walvisbaai project as a joint employer-contractor achievement. Again many thanks.

Please pass our appreciation to all authorities involved in this project.

The maintenance section under the late Jack Badham-Thornhill was nominally autonomous, but in practice it was integrated closely with the engineers on one

hand and the stores on the other. The specialised equipment, notably the dredger and the heavy mobile cranes for placing breakwater blocks, fell under this section.

The research section handled the oceanographic work. This included the instrumentation for wave and climate recording, model studies for breakwater design, and preliminary design studies. They had a standing arrangement with the laboratories at Stellenbosch University and did all their own model studies. Another innovation was the development of wind and tide gauges for installation at each harbour.

The survey section worked closely with Plessey to pioneer the use of tellurometers in hydrographic work worldwide, although with the advent of GPS this work has been largely superseded.

During the lifetime of the FDC they had begun to make their expertise available to other organisations. Examples are wave recording at Port Alfred, advice on commissioning the dredger in the Touws River at Wilderness, the breakwater at Alexander Bay, MCM trawl ground hydrographic mapping, and the boat ramp at Yzerfontein. They also encouraged self-improvement and a significant number of people qualified as technicians, engineers, registered land surveyors and town planners or acquired advanced qualifications through the corporation.

- 10 Saldanha Bay – Hoedjies Bay is in the centre of the picture, Pepper Bay at the top
- 11 Berg River Mouth – Laaiplek at top, Port Owen centre, Velddrift on the right
- 12 St Helena Bay (aka Sandy Point)
- 13 Lamberts Bay
- 14 Hermanus
- 15 Gansbaai



Chief Directorate Surveys and Mapping



Chief Directorate Surveys and Mapping



Chief Directorate Surveys and Mapping

EXTINCTION

The nature of the South African coast suggests that the provision of artificially protected water in South Africa should be a central government responsibility. Historically this has been the case. Since the inception of Union in 1910, the engineering management function for fishing harbours has been provided successively by the following:

- Department of Mines & Industries (1910–1933)
- Department of Commerce and Industry (1934–1936)
- Department of Public Works (1937–1939)
- SAR&H – Harbour Division (now NPA) (1940–1963)
- Fisheries Development Corporation – Technical Department (1964–1985)
- Department of Sea Fisheries (ex FDC) (1986–1987)
- Cape Provincial Administration – Works Branch – Coastal Structures (ex FDC) (1988–1990)
- Cape Provincial Administration – Works Branch (1991–1996)
- Department of Environment Affairs and Tourism – Marine and Coastal Management (from 1996)

In 1985, for politically inscrutable reasons, the FDC was disbanded and the engineering component moved to the Department of Sea Fisheries. A year later, in 1986, they were moved to the Cape Provincial Administration (CPA), to Works Branch, as part of the general policy of devolution popular at the time. So, too, was the administration of the harbours and the fisheries control inspectorate but to a different department, namely Nature Conservation.

This administration failed to husband the new acquisition and proceeded with what, in the private sector, would be called asset stripping. The corps of harbourmasters was disbanded and fisheries inspectors had to undertake that work in addition to their normal functions. Posts and budgets meant for the harbours and for the inspectorate were allocated to other departments. At the end of 1991 the engineers were made redundant and thereafter there were no engineering services available for the fishing harbours. Some ten years later the shell of both components was returned to MCM with very few (low-level) staff and very little budget. MCM made no attempt to rectify the situation.

By the year 2000, there had been virtually no maintenance of the harbours for the previous ten years. Many structures were inoperable or perilously close to collapse with risk of personal injury and even loss of life. MCM prevailed on the Department of Public Works (DPW) to accept the responsibility for the maintenance of the harbours.

DPW instituted a Repair and Maintenance Programme (RAMP) with which to undertake this maintenance. Currently they have expended about R340 million (the equivalent of about R1 billion on the original capital expenditure) and have brought the harbours back to the condition they should have been in had there been no hiatus in the maintenance works.

DPW are to be complimented for their efforts. The only comments are:

- RAMP is a maintenance programme with no provision for capital works. In some cases ageing structures should have been written off and demolished and in others new structures built or else the form and function of structures changed to meet changing demand
- The technical competence has been something of a curate's egg, depending on which consultants and which contractors were used

Back in 1990, while Margaret Thatcher's privatisation policies were still popular, the Commission for Administration were investigating ways and means of privatising or otherwise disposing of the fishing harbours. The old FDC engineers now with CPA sat in a number of meetings with them to discuss the issue. They also undertook a survey of the various municipalities, including the City of Cape Town, to sound out their interest in taking over the harbours. The response from all of them was enthusiastic, but it was clear that none of them, including Cape Town, had the capacity to do so.

The document that has probably done more to precipitate the present situation of the fishing harbours is the Floor Report of 1993 (more fully, the Report of the Committee of Inquiry into a National Maritime Policy for the Republic of South Africa, Stellenbosch, 1993).

The chairman, Bernal Floor, was a transport economist ex SAR&H and the study was dominated not so much by the interests as the perspective of shipping and the commercial ports. The committee adopted the high-minded but not very

informative goal for a National Maritime Policy of 'to achieve the optimum in the development and utilisation of all national maritime assets for the benefits of the nation'.

At the time that Bernal was making his inquiries, the fishing harbour administration had already totally collapsed. Other than a paper on the subject I had read to the 1991 National Maritime Conference and referenced in the report, he had no other informed guidance on the subject. Machiavelli, in his work on statecraft, makes the following comment:

It should be borne in mind that there is nothing more difficult to handle, more doubtful of success, and more dangerous to carry through than initiating changes in a state's constitution.

Conservatism in bureaucracies is not surprising. In keeping with Machiavelli's dictum, the Floor Committee essentially consolidated the existing maritime establishments, minus the fishing harbour administration, and explored future developments in these existing establishments in keeping with the goals. It made no attempt to explore re-establishing an independent fishing harbour administration.

The report does devote a section to the fishing harbours entitled 'Minor Harbours'. The fishing industry had in fact informed the committee of the situation with respect to the harbours:

The South African Inshore Fishing Industry Association has recommended to the Committee that the establishment, administration, management and maintenance of fishing harbours should be addressed in maritime policy. The Association is concerned about the efforts of the Cape Provincial Administration to shift this responsibility to local authorities which may be unable to afford the upkeep of the harbours. The consequences could impose a greater financial burden on the fishing industry or result in the eventual closure of the harbours to the detriment of the local communities.

The response of the committee was:

The fishing harbours obviously have benefits which extend beyond their use for commercial fishing, especially as recreational harbours and tourist attractions. Furthermore, the consequences of allowing the harbours to close would exceed the effect on



16 Dolos of 25 tonnes

17 Advanced corrosion in the splash zone. From a text on accelerated low water corrosion (ALWC) but more appropriate to accelerated high water corrosion (AHWC)

merely the local fishing communities. The subsidization of the fishing industry inherent in the low dues paid by fishermen, however, does not accord with the economic principle that the users of public infrastructure should be required to cover the costs of their use in order to avoid distortion in the utilisation of resources. The committee has sought information on how the expenditure on small fishing harbours is covered in other countries but has been unable to find examples in which the full recovery of costs from the users is required. Indeed, the upkeep of minor harbours in most countries is borne by public funds to which the revenue is added, without any attempt to relate the revenue to the expenditure or to dedicate it to such expenditure. In some countries minor harbours are under the jurisdiction of a regional port authority which merges the costs of their upkeep with the costs of maintaining all the basic infrastructure for which it is responsible.

The report points out that this last comment seems the only way to operate the fishing harbours and goes on to recommend that:

That jurisdiction over the thirteen proclaimed fishing harbours in terms of the Sea Fisheries Act, 1988 (Act 12 of 1988) be transferred to the

proposed national Port Authority and that the Port Authority be entrusted with the development, maintenance and operation of these harbours in accordance with the principles prescribed for the commercial ports.

Concurrently with the implementation of the DPW RAMP programme, MCM considered the matter of the administration of the harbours. In a memorandum prepared by Mr G de Villiers in 2002 he wrote:

The fishing harbours function cannot truly be described as a core function of either DEAT or NDPW and neither department singularly or collectively is at present adequately resourced to do justice to this function. Potential alternative arrangements include locating these small harbours with an authority with specific harbour management expertise, such as the National Ports Authority of South Africa (NPASA) or alternatively developing such expertise in either of, or a combination of DEAT and NDPW to empower the State to fulfil its obliga-





18 Ramp with displaced precast slabs

tions in this regard. Furthermore, in conjunction with Schedule 4B of the Constitution, it may be possible to transfer such authority to either the regional or local governments, but then the economic viability and capacity of such governments to be able to handle this responsibility, will have to be verified.

This in itself was a well-balanced opinion and, in 2003, led to the letting of a contract for a major study of the administration of the harbours. Unfortunately the terms of reference were confused and involved elements of both a search for a proper permanent harbour administration and an interim management of some of the functions of the administration of the harbours. Added to this, the extent of commitment to the process from the DG's office was insufficient to break bureaucratic logjams and allowed a festering impression within the organisation that the business of MCM was fishing not harbours, biology, not engineering and a desire to rid themselves of responsibility for the harbours. As a result the study proved to be completely ineffectual, leaving the *status quo* unchanged.

MCM today, instead of setting about rebuilding a really competent national

small harbour administration, seem to be groping at finding ways of disposing of the harbours and getting rid of their responsibilities. The resulting hiatus in fishing harbour administration is seriously compromising the management of these harbours and their ability to respond to the various demands placed on them, in particular the nationwide problem with security.

In 2006 another contract was let, this time with somewhat more coherent terms of reference. The relevant components of the terms of reference are:

- Assist the steering committee to identify the management authority
- Establish the current state of the harbours, taking into account the existing *status quo* reports and other related documentation, and identify priority areas for attention
- Investigate legal implications of the lease of the proclaimed fishing harbours to the management authority
- Conduct relevant/appropriate feasibility studies and make recommendations on how to grow the tourism potential of each harbour, support access to quay and berthing space for local fishers and stimulate local economic development
- Investigate legal implications with regard to harbours to be leased to

the chosen management authority (head lease)

- Collate database of existing leases/agreements in all the proclaimed fishing harbours and the terms and conditions governing these leases/agreements and assess the broader legal implications on the future developments within the harbours
- Develop and implement financial, developmental, marketing, cost recovery and medium- and long-term budgetary models
- Assist the steering committee to identify and develop a management authority

The terms of reference explicitly refer to identifying a pre-existing 'management authority' able to take over the administration of the harbours – as, for instance, municipal authorities. The Floor Committee suggestion of the NPA seems to have fallen away. It is perhaps fortunate that this has happened. While the NPA could and does manage fishing harbours in corners of its commercial ports, it is probably ill-suited to managing a suit of independent and remote fishing harbours.

Although the terms as written do not appear to preclude a *de novo*, proper maritime solution, they give no indication of or guidance towards such a direction. Rather they open up the exploration of non-

maritime commercial development. Here the archetype is the V&A Waterfront development. There has been a lot of hype published about this, running a working port, etc, but in truth it is a dry-land mall, hotel, restaurant and residential development on surplus space on the periphery of a major commercial port and, as such, small in comparison.

The precedent of the V&A is persuasive, however, and is already being touted as the solution to the fishing harbours. Unrestrained, this kind of solution could well be the death knell of these harbours. It would drive out maritime activities and close the sea to the people. Again, as in the previous study, the attitude of MCM will be critical to the success of the present.

The problem with MCM is particularly notable in the current Integrated Coastal Zone Management Bill. Admirably, it takes the view that people have a fundamental right of access to the seashore, but it is absolutely silent on their right of access to the sea. Of course, to be cynical, one could take the view that if the bill established such rights then, given the nature of the coast, the state would be liable to provide that access by physical intervention, that is, by small craft harbours – precisely the liability MCM are trying to evade.

The following statement should underlie any study to resolve the administration of the fishing harbours:

In view of the rarity of protected water on the South African coast, the public stock of fishing harbours are a national maritime asset that should not be alienated from this function although it is recognised that, from time to time, it may be expedient to allow surplus resources to be allocated on a temporary basis to landward commercial activities.

CONCLUSION

The plain fact is that, with few exceptions, the people of South Africa can only gain access to the sea from artificial harbours. Maritime activities of a fishery, tourism, recreational or other nature can generally afford the costs of infrastructure within protected water needed to further these activities but the added cost of providing protected water – that is, artificial harbours usually makes these activities uneconomical by international standards. Equally, the use of private small harbours, where these can be constructed economi-

cally for their promoters, will be limited to an exclusive few and exclude the general population

If the people of South Africa are to have a right of access to the sea, then by and large this access must be provided by the public sector. Given the high levels of expertise and of specialised equipment needed, this is best provided by central government.

The fishing harbours were a brave start and their administration, both technical and clerical, despite their shortcomings, could have served as a foundation and a template on which to build a proper vehicle to discharge the state's liabilities to provide the people with access to the sea. That resource has been largely squandered. Any fresh start will have to begin from scratch and reinvent the wheel with all the concomitant risks attached.

The various crux points in the evolution of the South African fishing harbours administration can be identified as:

- The inadequacy of the terms of reference of the Gilchrist Committee
 - The failure of the FDC to take ownership of the harbours and control both administration and engineering
 - The gutting of the harbours by the CPA
 - The failure of the Floor Committee to recognise the need for an independent minor harbour administration
 - An inappropriate attitude towards the harbours by MCM and by the Department of Environment Affairs and Tourism under which they fall
- There is a need for a competent and technically oriented national small harbour administration to manage, in the first instance, the existing suite of fishing harbours and, once established, the entire liability of the state to provide access to the sea and its liability for the management of physical intervention in the seashore throughout the coastline of the country.

Amongst the many advantages to a well-founded small craft harbour administration are:

- Continuity and long-term planning
- Established communication with local communities and users
- Close communication between administration and engineering
- Preservation of experience and development optimum standards
- A national nursery for coastal and harbour engineers

There is a need to review the funda-

mental priorities of government at the highest level with regard to policy regarding the rights of the people to access to the sea and the liabilities of the state to intervene in both physical and administrative aspects to enable and protect these rights.

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Keith Mackie has written two textbooks, *Dry Dock Manual*, the basis of his course on the practice of dry-docking ships, and *Basic Coastal and Harbour Engineering*, the basis of a SAICE CPD roadshow on the subject. He has read numerous papers on these subjects at national and international conferences. Keith is a member of SAICE and a fellow of the SA Institute of Marine Engineers and Naval Architects and is also involved in restoration engineering. The photographs were supplied by the author, unless stated otherwise

LOAD-SHEDDING EFFECT ON GAUTRAIN

CONSTRUCTION ON THE Gautrain Project has not come to a complete standstill due to the current spate of load-shedding activities by Eskom in Gauteng. Gautrain's 43 construction sites obtain power from 19 different substations to continue building over its 80 km route between Johannesburg, Tshwane and Ekurhuleni.

As Gautrain spans a vast geographical area, different construction sites will be without electricity at different times, depending on the load-shedding schedule. Construction sites are also not completely reliant on electricity. Where tunnelling takes place, emergency power supply systems are always fully operational. Therefore, some form of construction will always be functional whenever there is a power outage.

However, an area of special concern is Rosebank. *Imbokodo*, Gautrain's tunnel-boring machine, operates on electricity and a constant supply of electricity is needed to operate the machine 24 hours a day. Ongoing load shedding in this area will directly affect *Imbokodo's* operations.

Bombela, the private partner responsible for the construction of Gautrain, is still establishing the probable effect of envisaged load-shedding on the construction of Gautrain.

NATIONAL ROLL-OUT OF SOLAR-POWERED TRAFFIC LIGHTS LAUNCHED TO COMBAT TRAFFIC CHAOS

THE CENTRAL ENERGY Fund (Pty) Ltd has announced a massive drive to install solar-powered traffic lights at critical intersections in major cities to combat traffic turmoil caused by load-shedding.

Mputumi Damane, CEO of the CEF Group of Companies, said: 'This is an urgent intervention to help alleviate the chaos on our roads which results from power outages which are impacting negatively on the



► Solar powered traffic signal pilot project

economy of our country, whenever there is load-shedding.'

More than 2 000 critical traffic intersections have already been identified in Johannesburg. Key areas include Sandton, which has been hit hard by the power outages. The notorious Grayston–Rivonia intersection will be adapted to solar power.

The installation process is expected to begin soon. Certain components need to be imported, and intersections still have to be individually assessed.

Other major centres earmarked for solar robots include eThekweni, Port Elizabeth and Nelspruit.

In the past few days, about R40 million has been committed to the project in principle by public and private sector stakeholders.

The project will be managed by the National Energy Efficiency Agency (NEEA), a division of CEF, and will draw on a highly successful three month pilot scheme in Montagu's Gift, Cape Town.

Barry Bredenkamp, acting operations manager for the NEEA, said: 'Right now, commuters are at breaking point. Retrofitting robots to run on solar power is probably the best solution we have to solving the current traffic crisis.

'The test site confirmed that the technology is capable of running the lights on sun power and, crucially, without mishap,' added Bredenkamp.

He said the project was about alleviating the energy crisis in a broader context, as traffic congestion also wastes petrol and diesel unnecessarily.

'Quantified in monetary terms, productivity losses, accidents at uncontrolled intersec-

tions, and exhaust emissions from stationary motor vehicles all have an adverse effect on the economy,' concluded Bredenkamp.

THE SMART BUILDING BROUGHT TO SOUTH AFRICA

WITH A KEY focus on energy management and security, Bytes Systems Integration (Bytes SI) Kronos business unit, security distributor ADI International South Africa, and business partner Axis Communications South Africa have demonstrated to customers how they can make their business a smart enterprise.

Says Mark Freer, Business Development Consultant, Kronos at Bytes SI: 'Some of the biggest challenges facing South Africans today are energy management and security. With an enterprise wide EBI [enterprise buildings integrator] solution you can now manage, at a granular level, the switching on and off of air-conditioning systems, security systems and even lights, dynamically and remotely without replacing everything you have.'

Bytes and ADI International are providing customers with access to a comprehensive set of automation tools which will seamlessly combine all of your building systems onto a single platform. Through the use of open architecture and industry standards the system enables you to more 'smartly' manage your enterprise, combining security management, facility management and building management.

Richard Creighton, national technical leader at ADI International South Africa, says: 'In our experience when dealing with cus-

tomers there are many companies who feel that they could make use of an EBI solution in their business. Often the only deterrent is the notion that it firstly costs too much, and secondly the implementation thereof will be too disruptive to the enterprise.

'But the reality is you don't need to do it all at once, a simple migration path with an overall business objective of moving all of your systems in time, will enable you to view instant and tangible results and present these to your investors, and won't cost you the earth. This will ensure that the rands you save can start funding the future growth of your EBI objectives,' continues Creighton.

With an EBI solution from ADI International, clients can take advantage of a single view of the entire enterprise, including all facilities and operations. You can with immediate effect note how system management will impact the bottom line with reports and trend analysis of system power and facility usage. Through a single management interface you can now track, monitor and manage your entire building, paving the way for the smart enterprise.

'We believe in partnering with enterprises that unlock the true potential of our technologies. The EBI promise coupled with the technical expertise of Bytes now ensure that our IP-based security cameras are able to integrate into a system which can give you a single view of your business,' adds Jason McGregor, key accounts manager at Axis Communications South Africa.

The guest speaker at a recent enterprise breakfast hosted by the aforementioned parties, Andrew Etzinger from Eskom, has strengthened the message from the companies, highlighting how Eskom supply challenges can be eased by responsible energy management from private sector companies.

HOW CEBP WILL CHANGE THE FACE OF BUSINESS COMMUNICATIONS

COMMUNICATIONS-ENABLED BUSINESS process technology, or CEBP, is the next wave of innovation in business comms technologies. It entails the automation of human communications within business applications and includes:

- The continued integration of communica-

tion and workflow into 'business process-serving' applications such as enterprise resource planning (ERP)

- Presence management
- Advanced collaboration

Until now, says analyst Robin Bloor, communications automation has been confined to call centre systems and consumer-focused unified communications products, which tie up voice, instant messaging, e-mail and other collaborative tools. But CEBP goes much further than that. It integrates the many ad hoc communications and workflow aspects of a business process with the software that serves the business process.

CEBP is thus recognised as a catalyst for great change in the communications technology industry and end-user enterprise circles. It can be seen as the last frontier of automation of business processes, and it's on all the important providers' product roadmaps. Early product announcements prove that it is more than just a grand vision.

CEBP has been foreshadowed by business process automation in e-commerce, which drove the secure exposure of business processes to partners, suppliers and customers. It has traditionally been the domain of IT vendors. But a large percentage of commerce is communication. The new wave of business process automation will be communications and collaboration-centric. The applications that kick off business processes will feature the full triple play of voice, video and data communication choices, to allow the automated involvement of human communication (instantaneous or scheduled) that typically accompanies business processes.

How will this play out? To attempt an accurate prediction, it is necessary to track several other developments that will accompany the CEBP revolution. The following streams of technology development will mutually reinforce each other and support the CEBP wave, to bring about a totally different comms technology provider and user scene.

VOICE COMMODITISATION

Much like the commoditisation of the PC, communications network infrastructure will become commoditised, hosted on industry standard servers. Voice will be a basic component of the operating system. Just as software became the seat of innovation in the PC game, value-added voice applications will be the main area of differentiation. While it is difficult to see who will win the battle for dominance, companies like Microsoft, with its Office Communications Server, are most likely to end up as the voice icon on business desktops.

DESKTOP INTEGRATION

This will mean tight desktop integration between productivity or business apps and the voice application. Initiating voice calls from within applications will be a mouse-click away. As a commodity, voice applications will be standards-based, allowing easy, tight office and business application integration.

APPLICATIONS

Presence management is a big driver in this revolution. Applications will port easily between different operating platforms, handing choice of communications channel to users. An intelligent enterprise backend incorporating directory services will ensure users' profiles (contact books and applications) follow them to whichever platform they are currently active on, such as a smartphone.

DEVICES

Users' behaviour will dictate whether they work predominantly from home (PC), the office or on the move. The device war is far from won.

PROVISIONING

Hosting will increasingly be the means to deliver application services, including voice, directory services and other applications. The communications network will be end-to-end Internet Protocol-based (IP), meaning the device and the hosted service can communicate seamlessly, wherever the user is, and whatever device he or she chooses to communicate through. Currently, such remotely accessed services are in large measure localised – with a business running a PBX that routes requests for an application hosted on a company server. It's possible, but still requires work.

INDUSTRY IMPACT

The impact on the industry will be significant in the medium term. Some traditional voice infrastructure providers will change their tune and pour research and development into their application and integration competencies. Others will disappear in the consolidation that usually follows margin-eroding commoditisation. The application providers hoping to add value will have to ensure their applications run on PCs, phones, PDAs and the home phone. Companies that integrate voice solutions will employ business application consultants that understand the customisation and integration of voice solutions into the communications-enabled enterprise architecture.

A REVOLUTION

CEBP is a sweeping technology revolution that will affect the communications technology provider landscape, as well as the enterprise end-user, in many significant ways. The way to prepare for it is through the adoption of standards-based software and hardware platforms, and by means of a paradigm shift that embraces business process thinking and rejects purpose-built solutions.

► TEXT

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'MUST INCLUDES' FOR PUBLIC SECTOR TENDERS

A TENDER FOR a public sector project will only be successful if it meets myriad criteria but it will not even get on to the table for serious evaluation if it neglects to include just a handful of crucial pieces of information.

This is the advice of Theo Poovalingam, a specialist in inbound supply chain and procurement, with considerable experience in public sector procurement legislation and regulations and regulations, as well as other government SCM legislations and policies (such as demand management, logistics management, disposal management, performance management).

During his ten years working closely with government, he has isolated those few critical areas where most tenders fall short, and consequently do not even merit a second look by the procurement officers charged with evaluating all submissions.

Poovalingam intends to highlight these areas at a round table event to explore government procurement policies. Hosted by South Africa's Association of Proposal Management Professionals (APMP), it takes place in Woodmead, Sandton, in February (www.apmp.org).

Another specialist participating in the round table will be Riana Bredell. Her forte lies in the interpretation of all public sector legislation and how to react to. Bredell is in charge of public sector supply chain and procurement for Deloitte and has 23 years of experience in the field. She submits proposals and manages procurement processes on behalf of public sector clients, receives tenders and judges



them, and is actively involved in advising government. 'Anyone whose new business pipeline depends on tenders – be they to the public or private sectors – should consider attending this round table,' said Ann Visser, business development manager at business software solutions company, nFold, and one of the co-founders of the budding South African chapter of the APMP.

'Tender preparation is not an exact science but successful tenders are based on sound communication as well as technological principles. We can all learn to improve our own tender compilation procedures from those who are experts in the field, and this round table is one such opportunity.'

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PRECAST CONCRETE ELEMENTS DOMINATE IN NEW HOUSING PROJECT



PENNYVILLE, AN AFFORDABLE housing project in Pennyville Ext 1 opposite New Canada Station, south-west of Johannesburg, is being constructed almost exclusively with precast concrete components. The project is being developed and funded by the City of Johannesburg, and Pennyville Zamamphile Relocations (Pty) Ltd (PZR) is the turnkey contractor.

Everything, apart from the foundation

- ① Prestressed hollow-core concrete slabs manufactured by Echo Prestress, shortly after being lowered into position on one of the double-storied housing units at Pennyville
- ② High-quality affordable housing, most of it built using precast concrete elements, predominate at Pennyville. The picture shows houses built with Sedibeng concrete bricks and roofed with Lafarge concrete tiles, a path paved with Concor Technicrete's concrete blocks, and prestressed concrete poles manufactured by Infracrete
- ③ Precast concrete was used extensively at Pennyville and, as is shown here, included staircases supplied by Pre-Cast Staircase, on the multi-storeyed units
- ④ One of the houses at Pennyville which is being built with diamond-faced concrete bricks



platform, uses precast concrete. This includes the masonry, roofing, upper level flooring, paving, reticulation poles, kerb stones and sewer piping. Even staircases for the multi-storeyed units utilise precast concrete.

PZR is responsible for the planning, design and project management elements. Civil engineering consultancy Bigen Africa is handling the civil work design aspects, and Civtek cc is the main civil works contractor. The primary above-the-ground contractor is Sea Kay Engineering Services (Pty) Ltd, which boasts a CIDB rating of 8.

The project has been designed with three occupier categories in mind and, when completed, Pennyville will comprise 2 800 units in 36 m², 40 m² and 42 m² variants, mainly as single-storey units, but also as double- and triple-storey units.

Approximately 1 400 houses will be allocated to qualifying RDP beneficiaries from the Zamamphile informal settlement. These houses form part of the Housing Council and National Housing Department's commitment to housing development, and will be owned by the beneficiaries under sectional title.

One of the huge advantages of Pennyville is its close proximity to the centre of Johannesburg. Some 400 units will be owned by JOSHCO, for renting to people who

already own a home elsewhere but require accommodation closer to their place of work. They will be given the option of either leasing whole units or individual rooms within three-bedroomed units, depending upon their requirements.

The remaining 1 000 units will be purchased by banks and will either be leased or sold to owner-occupiers.

John Cairns, director of the Concrete Manufacturers Association (CMA), says that the dominance of precast concrete in the construction of Pennyville demonstrates emphatically its versatility and inherent quality.

'The use of diamond-faced concrete bricks, concrete roof tiles and concrete block paving on the paths between the houses, means the development will have an attractive homely appearance even before the establishment of gardens and the planting of trees,' notes Cairns.

The RDP and JOSHCO units will comprise a living area, a bathroom with a wash basin and toilet and pre-paid electricity. The RDP units are being built without ceilings or baths, the intention being to provide housing which can be upgraded as the prospects of the owner-occupiers improve. Owners who install baths and ceilings, and plaster the inner walls, will be able to qualify for a bank loan.

The project is being built in four phases, civil works having commenced towards the end of 2006. Phases one, two and three of the RDP and JOSHCO units have been completed and phase four will be completed by April this year. Occupation of the first completed units began in August.

The houses are being built on concrete platforms with steel-reinforced foundations, which are based on a Waffle Raft design to prevent cracking in the event of soil heave or movement. Foundations are laid with 400–450 mm edge beams to support the platforms, and concrete floors are cast to either 20 MPa or 25 MPa, depending on geotechnical conditions. After power floating they are left to cure under moist conditions for a week.

Masonry work entails using 10 MPa concrete single maxi diamond-faced bricks measuring 140 mm x 290 mm x 90 mm, which are being supplied by Sedibeng Bricks in Meyerton.

'Diamond-faced bricks are an attractive alternative especially for this type of development where there are many houses of uniform shape and size in close proximity,' notes Cairns.

Prestressed hollow-core slabs manufactured by Echo Prestress according to specifi-

cations laid down by the project's structural engineer, Victor Booth, are being used for the flooring of the double- and triple-storeyed units. Even the staircases are made of precast concrete and these are being supplied by Pre-Cast Staircase, as are the lintels and the prestressed beams.

Gary Clark, Sea Kay Engineering Service's on-site project manager, says the use of prestressed hollow-core flooring means that masonry work can begin on the upper floors as soon as the flooring has been laid.

'This is saving at least a week's construction time on each house. Similarly, the use of a precast concrete staircase also aids quicker construction times.

'Once the masonry work and roofing have been completed, the walls are bag-washed on the inner and outer surfaces. A good quality paint from Prominent Paints is then used on external walls, which together with the bag wash, ensures excellent waterproofing properties,' observes Clark.

Concrete roof tiles supplied by Lafarge Roofing are being laid on a low-cost steel truss system. A recent survey conducted on behalf of the CMA demonstrates that concrete roof tiles are the most cost-effective form of roofing on roofs built with trusses.

'They are also aesthetically pleasing, im-

buing pride of ownership and enhancing the value of the houses on which they are used considerably,' says Cairns.

Concrete paving blocks for the pedestrian paths are being manufactured by Concor Technicrete, and prestressed concrete poles for overhead power supply cables were manufactured by Infracrete Infrastructure Products. Approximately 1 000 poles in four sizes ranging from a 7 m 4 kN pole to a 10 m 8 kN pole were installed by Kusokhanya Electrical Contractors.

Precast concrete kerbing is being supplied by Rand Kerbing, Blitz Beton and Concor Technicrete and the stormwater pipes come from Cula and Infracrete. Sewer manholes were supplied by Salberg.

Besides providing much needed additional housing, the Pennyville project has provided work to previously disadvantaged sub-contractors. They are sub-contracted to Sea Kay Engineering with the proviso that they are registered, have the requisite skills and are based in South Africa. Where necessary, Sea Kay is providing additional skills training in collaboration the National Home Builders Registration Council (NHBRC).

AN IT ENTREPRENEUR DISCOVERS THE VALUE OF SYSTEMS

IT'S A COMMON MANAGEMENT idea that there are only three possible problem areas in a business: technical skill, values and behaviours, or organisational systems – but the last point may only really make sense once you've actually tried running a company yourself.

For an IT person running his own business supplying customer relationship management (CRM) software to large companies, it's been an interesting experience to discover that 'systems' is not a word that applies only to software. The emphasis on systems and process always sounded like consultant-speak to me; but my observations of clients, as well as experience in my own company, have convinced me that the most successful businesses are built on excellent systems.

A good system doesn't have to be software-based (although software often helps). It's often as simple as a manual that explains to every employee exactly what to do, when and how – provided the manual also includes ways to measure performance and make

people accountable for it.

In essence, a company's systems, its way of doing things, are what really make it unique. They answer fundamental questions like 'what really makes our business succeed?'. The best systems are driven by the business's leaders, with the thorough involvement, understanding and support of everyone else in the business. They are a form of collective intelligence, evolving as the group learns and feeds its experience back in.

Here's an example of why systems are important. In the CRM space we've seen plenty of software implementations that have gone wrong. In most cases two factors stand out: hardly anyone actually uses the software, and senior managers seem scarcely aware that it exists.

We've come to realise that what really underlies this is a failure of organisational systems. If there's already a clear system in place that is driven by senior managers and defines exactly how you deal with your customers, then good software slots right in and helps the whole thing run better. But if there isn't a system to start with, then no software in the world can replace it. We've seen too many companies try to fix organisational problems with one software implementation after another, wasting millions on IT systems when what they should be concentrating on is organisational systems.

It's hard to overstate the importance of this: every long-term successful business we've dealt with can take us straight to their operations manual and show us how they do things. The manual is a living document, regularly updated with new learnings and the foundation of induction training for all new employees.

It's not rocket science – in fact, the simpler company systems are, the better. The scary thing is how few businesses have these systems, communicate them well to their staff and measure their performance. It's the easiest way to eliminate inefficiency.

At one leading professional services firm, we saw our CRM software used as an integral part of a carefully planned sales and marketing system that resulted in real revenue growth for the firm. There was nothing magical about this success: the company designed a system to achieve what it wanted, communicated it clearly to everyone, and then measured its performance. Data from the CRM software was examined at board meetings to see how many leads were being created and what progress was being made. There was never any discussion of 'how do we get people to use the CRM system', because

using it was part of their jobs.

Applying these insights from leading firms has helped my own, much smaller company perform better as well. We've always used the CRM software that we sell and diligently logged all our contacts, but it never really helped us grow until we sat down and worked out how to use it better. Now we have a clear system for following up cases, measuring our performance against SLAs and incorporating new learnings. We're still capturing the same data, but now it has a purpose and meaning that has transformed our work.

We didn't, incidentally, hire consultants to do this for us. An army of consultants can document and analyse your business processes forever – but in the end, only you know your business and only you can design the systems that will make it fly.

In all this, software is a valuable enabler – but never a substitute. It's a strange thing to say for someone who makes his living selling software, but we will welcome the day clients only call to implement systems for them, not design them.

► TEXT

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SOUTH AFRICA HAS MUCH TO GAIN – AND LOSE – IN AFRICAN OIL SECTOR

AFRICA'S GROWING ROLE in oil exploration and production was the key theme of the 14th annual Africa Upstream conference in Cape Town in October last year. The upcoming Oil Africa conference and exhibition in March 2008 will build on this by highlighting the opportunities for South Africa and Africa to localise supply to the oil, gas and petrochemical sector.

Jack Holliday, an independent energy advisor based in Cape Town, commented that the Africa's Upstream conference, which attracted more than 400 high-level delegates, aimed to identify exploration and production. Significant emphasis was placed on Africa's emergence as a key world supplier of both crude oil and natural gas at the recent Africa Upstream conference.

Holliday reported that Africa's production was expected to grow from its present

6 mmbbls/day to about 14 mmbbls/day by 2030, requiring an investment of more than US\$275 billion.

'All of Africa needs to gear itself to benefit from this expenditure,' he said. 'Significant improvement in infrastructure has occurred in Angola in line with the growth of the oil sector in that country, for example.

'It is critical that South African industry maintains the momentum that will secure our future as a key player in the African oil and gas sector. This will be the strong message that comes through in Oil Africa 2008, to be held in Cape Town in March.'

The South African Oil and Gas Alliance (SAOGA) is coordinating the approach of South African companies to the opportunities and significant progress has been made with the recent commissioning of the Saldanha Bay fabrication facility and the ever increasing flow of drilling rigs passing through the Cape Town Harbour for refurbishment.

The announcement by PetroSA of its intention to build a 200 000 bbl/day refinery at Coega and Forest Exploration International (SA)'s plans to develop the offshore Ibhubesi field north of Saldanha Bay indicate the growth anticipated by the industry.

The theme of the 3rd Sub-Saharan Oil and Gas conference and exhibition, Oil Africa 2008, 'Managing change in the African oil and gas industry', is opportune as Africa's oil industry starts booming and high oil prices look set to continue.

The conference and exhibition in Cape Town will focus on Africa's and, more specifically, South Africa's willingness and ability to meet the growing demand associated with the industry. Not only will the exhibition demonstrate existing capacity, but future needs such as training and infrastructure development will be raised. Participants will also be brought up to date on Asia's growing role in the African oil industry.

Sonangol, Russian and Chinese oil and gas producers and suppliers to the industry will be exhibiting at Oil Africa 2008 for the first time.

Oil Africa will take place at the Cape Town Convention Centre from 17 to 19 March 2008. 'The opportunities are there,' said Holliday. 'Those who do their homework will benefit.

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INTERMAP AWARDED CONTRACT BY ALFRED NZO MUNICIPALITY

INTERMAP HAS SIGNED a contract with the Alfred Nzo District Municipality to implement its District Information Management System (DIMS). DIMS is a customised information management solution which will integrate with the municipality's existing systems in order to better manage the heavy flow of information running through the organisation to improve overall effectiveness, which will directly benefit communities.

In recent years, pressure has been placed on municipalities by parliament to increase responsibility in improving their service delivery, accountability, transparency and good governance. In achieving this it has become clear that the traditional information system – combining paper, electronic devices and even word of mouth methods – will no longer make the grade and, therefore, a stronger foundation of information management and

control needs to be put in place. This need for a more efficient method of information control has arisen largely due to the huge increase in the number and types of projects that municipalities are now required to manage.

The solution to this problem of information flow, then, has been put forward by Intermap, in the form of its DIMS. DIMS is a web-based system that allows for the capture and transference of pertinent and useful information to the correct people. It provides the user with the ability to achieve various tasks through an easy-to-use web interface, with 11 integrated modules based on Intermap's eTrack proven application development platform.

The agreement with the Alfred Nzo Municipality – based in Mount Ayliff in the Eastern Cape – follows the Office of the Premier accepting DIMS as a standard for integrated management systems in the province, with the Amathole and OR Tambo District Municipalities already having completed a full implementation of DIMS. DIMS has already been accepted by KwaZulu-Natal as the standard for integrated management systems to be implemented at all district municipalities.

FIRST BOARD PRESSED AHEAD OF SCHEDULE

THE NEW P G Bison Board plant near Ugie in the north-eastern Cape pressed its first board at 17:01 on Thursday 13 December 2007 – a month earlier than originally planned.

The 1 000 m³ per day particle board plant is the pivot development in a forestry cluster intended to extract maximum value from the raw material by utilising the entire tree in an integrated operation. The board plant covers some 36 ha of the 64 ha site which is designed to accommodate possible future timber beneficiation processes.

Further value will be added to the raw board in a 35 000 m² per day melamine faced board press which was successfully commissioned, on schedule, on 16 October 2007.

Despite it being the eve of the builders' holidays, all hands were at the press, waiting in anticipation as the commissioning team held together the very complex process of getting the thousands of inputs and outputs synchronised to produce the first board.

① Despite it being the eve of the builders' holidays, all hands were at the press, waiting in anticipation as the commissioning team held together the very complex process of getting the thousands of inputs and outputs synchronised to produce the first board

② The first board on the largest and most modern press of its kind was pressed at 17:01 on Thursday, 13 December

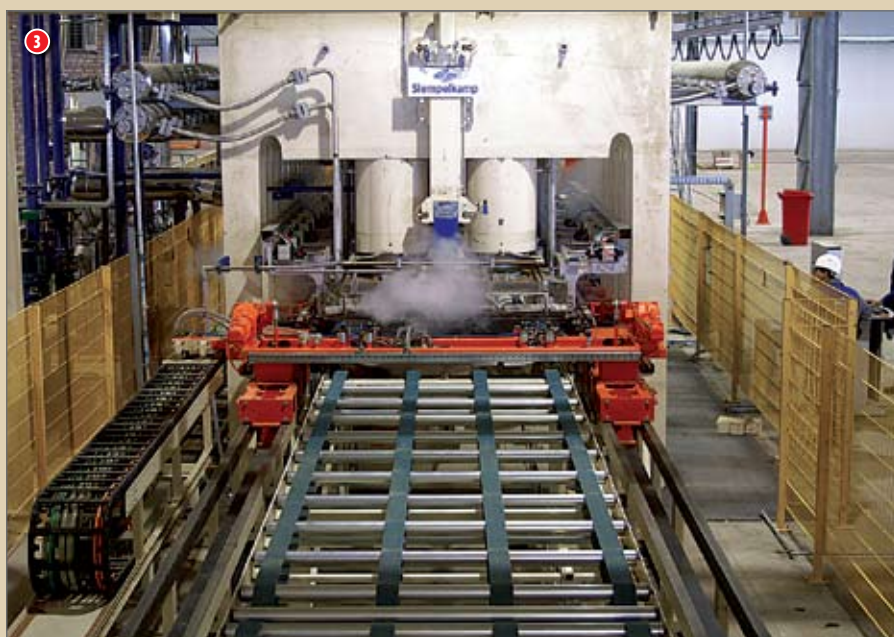
③ Further value will be added to the raw board in a 35 000 m² melamine faced board press which was successfully commissioned, on schedule, on 16 October

An elated Jörg Weeber, executive director responsible for the development, was full of praise for the P G Bison project team and the technical specialists from abroad. 'They have delivered on time – this is the best Christmas present ever,' he said.

P G Bison Project Manager Gerhard Victor, similarly elated, believes that making the first board ahead of schedule is an important psychological milestone to energise his team to now take this R1,5 billion greenfield development into production.

Many of the new production staff spent a considerable amount of time receiving on the job training at facilities elsewhere in the country. Key personnel was sent abroad to learn the specifics of operating the continuous press – the largest and most modern press of its kind in Africa.

Preparations in the surrounding North Eastern Cape Forests (NECF) to supply the board plant with 1 300 t of timber per day are on track with mechanised harvesting operations and road networks having been established. The Forest Stewardship Council (FSC) certificated timber for the plant will come from P G Bison's own 40 000 ha plantations.



CONCRETE MANUFACTURERS ASSOCIATION INVITES ENTRIES TO ITS AWARDS FOR EXCELLENCE COMPETITION

THE CONCRETE MANUFACTURERS Association (CMA) will be staging its 12th Awards for Excellence competition in 2008.

CMA Director John Cairns says that the purpose of the awards is to recognise excellence in the aesthetic, engineering and creative use of concrete manufactured products,

and to honour those involved in the application of these products either through design or construction, or both.

‘The event presents an outstanding opportunity for southern African designers and project developers to establish themselves as trendsetters in various related disciplines and to gain national recognition for their achievements,’ says Cairns.

Held biennially, the competition is open to all designers, developers, manufacturers or users of precast concrete products, and entries may be submitted by individuals, partnerships or companies in the following divisions:

- Concrete Block Paving
- Concrete Roof Tiles
- Concrete Masonry
- Concrete Retaining Block Walls
- Suspended Concrete Floor Slabs
- Infrastructural Products
- Community Upliftment

These divisions contain several sub-categories, which are broken down in the entry form. The first four categories listed above include a Vintage sub-category for projects completed ten or more years ago.

‘This category was introduced in 2000 and is growing in popularity. It proves that

concrete products are not only durable but also retain their aesthetic appeal over the long term. Community Upliftment was introduced as a category in 2006 and we are expecting it to attract considerably more entries this year,’ says Cairns.

Apart from the Vintage entries, only projects which have been completed since 1 January 2006 qualify for entry.

Cairns says that awards are made on a regional and national basis.

‘Regions include KwaZulu-Natal, Eastern Cape, Western Cape and Inland. Coastal-based regional awards will be made to winning sub-category entries at regional ceremonies held in Durban, Port Alfred and Cape Town.

‘National awards are made to the winning entry of each sub-category. These awards, as well as the Inland regional awards and the four CMA floating trophies, are presented at a gala awards banquet, which will take place in October in Gauteng.

‘The most prestigious awards comprise four floating trophies which are sponsored by international pigment manufacturer, Cathay Pigments. These will be awarded to the overall national winners in the Masonry, Paving, Roof Tiles and Other Concrete

Products categories,’ notes Cairns.

Cairns says the competition standards are high and if not met in any of the categories the CMA reserves the right to withhold an award in that category.

Entry forms are available from the CMA website www.cma.org.za and the closing date for entry submissions is 31 May.

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MICROTUNNELLING AND PIPE JACKING COMPENDIUM IN PREPARATION

IN THE LAST 25 years the emergence of microtunnelling and modern pipe jacking methods has created a sea-change in the way pipelines and utility tunnels are designed and constructed. These techniques have replaced more traditional ways of tunnelling in diameters from 1 200 mm to 3 000 mm (48"

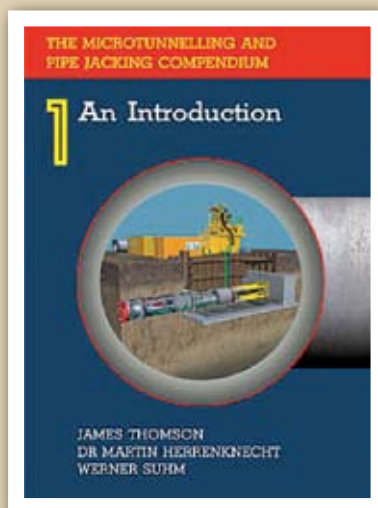
to 120"), but also allowed for smaller non-man entry diameters of pipes from 300 mm to 1 200 mm (12" to 48"), previously constructed by trenching, to be installed by remote control microtunnelling.

Jacked-pipe approaches have opened up a huge range of infrastructure applications not only for pipelines but for underground structures. The market for these new tools has expanded rapidly involving extensive equipment innovation and development. Today virtually any ground conditions from the hardest rock to the most unstable soil below the water table can be handled safely and economically.

The pace of these developments has been such that there is an urgent need for all those involved in the pipeline and tunnelling industry to have a definitive reference and a guide to the latest technology and developments.

Three professional engineers have joined forces to provide a comprehensive, all-embracing coverage of the subject.

■ James Thomson, the lead author, is a chartered civil engineer and an acknowledged expert in the field of pipe jacking and microtunnelling. He has worked interna-



tionally as a contractor and consultant for more than 40 years pioneering and implementing many developments. In the 1990s, he wrote *Pipe jacking and microtunnelling*, which became a standard work

■ Martin Herrenknecht graduated in mechanical engineering and is one of the best-known names in the tunnelling world. He is founder and chairman of the board of Herrenknecht AG, the world's largest manufacturer of tunnelling sys-

tems. With more than three decades of experience in tunnelling he has been directly involved in many of the technology developments. Numerous awards have been made to mark his contribution to tunnelling technology

■ Werner Suhm graduated as a mechanical engineer. He has been working for Herrenknecht AG for more than two decades and is vice-president and member of the management board. He is responsible for research and development of Herrenknecht's pipe jacking and microtunnelling systems. This provides unique insight into the machines, the support equipment and their operation

The many aspects that need to be covered would mean an unwieldy tome of many hundreds of pages. The authors have decided that the best approach is to develop a series of five self-contained books, each one directed at some major aspect of the subject:

■ **Volume 1: An Introduction** Overview of the concepts, technology, applications, economics and the use of jacked-pipe methods worldwide

- **Volume 2: Engineers** Engineering concepts, site investigation and design of the permanent works
- **Volume 3: Contractors – Planning the Work** Evaluating and planning the work – technique selection, shafts and temporary work design
- **Volume 4: Contractors – Equipment and Operations** Equipment selection – TBMs, cutting heads, spoil removal, jacking rigs, jacking load reduction, guidance and support equipment
- **Volume 5: Clients – Economics and Contracts** Economic evaluation – direct, indirect and environmental impacts, contracts, specifications, client supervision and disputes

The first volume is planned to be available in early fall 2007; the other volumes will follow at regular intervals. Individual volumes can be bought separately or as a whole set in a case box.



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SUNSPOT IS HARBINGER OF NEW SOLAR CYCLE, INCREASING RISK FOR ELECTRICAL SYSTEMS

A NEW 11-YEAR CYCLE of heightened solar activity, bringing with it increased risks for power grids, critical military, civilian and airline communications, GPS signals and even cell phones and ATM transactions, showed signs it was on its way when the cycle's first sunspot appeared in the sun's Northern Hemisphere, NOAA (National Oceanic and Atmospheric Administration) scientists said.

'This sunspot is like the first robin of spring,' said solar physicist Douglas Biesecker of NOAA's Space Weather Prediction Center (SWPC). 'In this case, it's an early omen of solar storms that will gradually increase over the next few years.'

A sunspot is an area of highly organised magnetic activity on the surface of the sun. The new 11-year cycle, called Solar Cycle 24, is expected to build gradually, with the number of

sunspots and solar storms reaching a maximum by 2011 or 2012, though devastating storms can occur at any time.

During a solar storm, highly charged material ejected from the sun may head toward Earth, where it can bring down power grids, disrupt critical communications, and threaten astronauts with harmful radiation. Storms can also knock out commercial communications satellites and swamp Global Positioning System signals. Routine activities such as talking on a cell phone or getting money from an ATM machine could suddenly halt over a large part of the globe.

The new sunspot, identified as #10,981, is the latest visible spot to appear since NOAA began numbering them on 5 January 1972. Its high-latitude location at 27 degrees north, and its negative polarity leading to the right in the Northern Hemisphere are clear-cut signs of a new solar cycle, according to NOAA experts. The first active regions and sunspots of a new solar cycle can emerge at high latitudes while those from the previous cycle continue to form closer to the equator.

'Our growing dependence on highly sophisticated, space-based technologies means

we are far more vulnerable to space weather today than in the past,' said Vice Admiral Conrad C Lautenbacher, Jr, under secretary of commerce for oceans and atmosphere and NOAA administrator. 'NOAA's space weather monitoring and forecasts are critical for the nation's ability to function smoothly during solar disturbances.'

SWPC is the nation's first alert for solar activity and its effects on Earth. The centre's space weather forecasters issue outlooks for the next 11-year solar 'season' and warn of individual storms occurring on the sun that could impact Earth. SWPC is one of NOAA's nine National Centers for Environmental Prediction and is also the warning agency of the International Space Environment Service (ISES), a consortium of 11 member nations.

► **Source:** NOAA website

LOAD-SHEDDING 'HUGE CONCERN' FOR SA BUILDING SECTOR

MASTER BUILDERS SOUTH AFRICA (MBSA) and its member organisations have expressed deep concern regarding the implications for the building industry of Eskom's power generation problem.

MBSA President Eunice Forbes said in a statement on 5 February that it was a 'huge cause for concern'. MBSA had not yet been able to fully quantify the potential negative impact on the industry and contractors but a survey is under way to gather more information from members about the estimated overall effect on their contracts.

'Building contractors may well seek compensation for the time loss and costs incurred due to the electricity supply problem. This issue also impacts significantly on health and safety conditions on building sites. It already appears that one worker may have lost his life directly as a result of load shedding. MBSA has commissioned an investigation into the potential contractual liabilities,' Forbes stated.

The many challenges facing employers in the building industry do not stop with the current unreliable supply of electricity, MBSA CEO Pierre Fourie maintains.

'The industry, particularly the residential sector, is already under pressure from rising interest rates and is starting to show more than just a slowdown in growth. Developers



► *Eunice Forbes, president of Master Builders South Africa: 'It already appears that a worker may have lost his life as a result of load-shedding,' she has stated*

regularly experience delays in building plan approval and rezoning applications, which in turn have an effect on builders' programmes – in addition to the required ancillary services. Moreover, builders may face potential uncertainties concerning the availability of building materials in future because of load-shedding's effect on material manufacturers,' he stated.

Fourie added that Master Builders South Africa and its association members' companies supported Eskom's call to South African industry to reduce electricity consumption.

HIGH-END FINITE ELEMENT ANALYSIS TOOLS FOR CIVIL ENGINEERS AVAILABLE IN SOUTH AFRICA

SINCE THE VERY first engineering software applications using finite element method (FEM) technology in the 1960s, computer processing power determined the size of problems engineers could solve with FEM applications. Today we have very powerful computers with more processing power available to software developers, to develop new calculation algorithms in FEM products.

Until now high-end civil specific FEM software was only available through overseas vendors. Solidcad recently sold CivilFEM products to Pebble Bed Modular Reactor (Pty) Ltd, a leading company in nuclear power generation.

FEM software applications

FEM software applications (such as ANSYS/

CivilFEM) can help the civil engineer in the design and validation process of high-rise buildings.

Foundations

The foundation of every skyscraper is just as important as the rest of the structure and should be studied carefully considering the loads they receive from the structure it supports. Conditions like wind, soil type and mass needs to be taken into account and approximation formulas can not always be used to design these foundations. These conditions deliver non-linear soil-structure interaction problems complicating the design process.

Structure

When a conventional building of ten or fifteen floors is planned, the use of linear calculation programs, with subsequent reinforcement of columns or concrete beams with code checking of the steel and concrete components, is a perfectly admissible practice and very common in actual engineering.

From experience these types of buildings are familiar to engineers, but when we get to high-rise buildings civil engineers have to study loads and the effects in detail. High-rise buildings are much more sensitive to wind, shock loads (seismic effects) and thermal changes than conventional buildings.

It is necessary to look for more exact solutions that are not empirical.

In cases like these, finite element analysis (FEA) is irreplaceable – allowing engineers to make mathematical models of the structure in which the non-linear as well as the creep and shrinkage behaviour of the materials, loads and structural elements are simulated.

FEA models

ANSYS/CivilFEM will break structures up into elements and nodes. Loads are transferred onto the mathematical model from which engineering equations are compiled and solved by the software to provide the engineer with a graphic interpretation of stresses, strains and deformation through the structures. The engineer can now use these results to neutralise stress, strain and deformation.

ANSYS/CivilFEM

Solidcad specialises in the sales and support of ANSYS products in South Africa and recently added CivilFEM to their range of solutions.

► **INFO**

Izak Vorster

Solidcad

T 012-665-1600

► Felix Fongoga, Elsabé Kearsley
and Santie Gouws

PEOPLE



SAACE PRESIDENT 2008 INAUGURATED

The South African Association of Consulting Engineers (SAACE) inaugurated its youngest president ever in October last year.

Felix Fongoga takes up the role at a time when the construction industry is showing strong growth in the context of a healthy and expanding economy.

Fongoga, CEO of ILISO Consulting, graduated from the University of the Witwatersrand with a BSc Engineering degree in 1988 and a Graduate Diploma in Engineering in 1990. His key engineering expertise is in the fields of water engineering and municipal infrastructure. He has also, over the last couple of years, developed a passion for contract law.

Fongoga's involvement and service to the engineering industry goes back to his days

at university where he served on the South African Institute of Civil Engineers (SAICE) student chapter at Wits, and then as graduate representative of the Border-Kei branch of SAICE as well as on its national graduates committee. He has also served in various portfolios for the South African Black Technical and Allied Careers Organisation (SABTACO).

NEW HEAD OF DEPARTMENT AT UP

SAICE President Elect Elsabé Kearsley is now head of the Department of Civil Engineering at the University of Pretoria. She also chairs SAICE's Editorial Panel.

SANTIE GOUWS JOINS C&CI TECHNICAL STAFF

Materials engineer Santie Gouws has joined

the technical staff at the Cement & Concrete Institute (C&CI).

After obtaining her degree in civil engineering at the University of Stellenbosch, Gouws joined the VKE Bridge Design office in Cape Town. She attained her civil engineering master's degree cum laude – with a thesis on concrete durability – at the same university.

After moving to Gauteng, Gouws joined PPC as cement applications engineer and also served as PPC's representative on the C&CI Technical Committee.

She achieved the highest marks globally in the prestigious Advanced Concrete Technology Course (ACT) at the C&CI School of Concrete Technology in 2002. Her ACT research report covered the evaluation of the micro-concrete slump cone. ■

PAST MASTER 13

Patrick Fletcher



THE NORTHWESTERN CAPE is not the most hospitable part of South Africa, and young Patrick Fletcher, who hailed from the island of Jura off the coast of Scotland, must have had mixed feelings when he arrived there in 1850.

Fletcher was born in 1827 and obtained formal qualifications as a civil engineer and as a geologist before ar-

► Messelpad Pass

riving in South Africa. Here, strangely, he found that opportunities in his chosen fields were limited, so he studied for and passed the examinations for admission as a land surveyor – a calling for which, in a rapidly expanding country, there was a greater demand. He then took himself off to Namaqualand, which was experiencing a copper mining boom. This economic windfall was threatened, however, by the difficulty in transporting the ore to

PAST MASTER 14

Richard Thomas Hall

ORE FROM THE Namaqualand copper mines was shipped to Cornwall for treatment, so it was perhaps natural that the Cape Copper Company should appoint a Cornishman to investigate its transport problems.

Richard Thomas Hall, the engineer who conceived, designed and built the narrow-gauge railway through the forbidding country from Port Nolloth to Okiep, was born in Falmouth, Cornwall, in 1823. His experience as Superintendent of the narrow-gauge Redruth to Chacewater Railway and of its conversion from horse to steam traction stood him in good stead when it came to tackling the transportation problems of the Namaqualand copper mines.

He arrived in Namaqualand in 1865, enlisted the help of surveyor Patrick Fletcher (PM 13), and carried out extremely thorough investigations into the various options for getting the copper

to the coast. He did not exclude road transport from his studies, but he must soon have become aware of the difficulties attached to this mode, particularly the seasonal lack of water and forage for draught animals, which meant that the riding season was limited to a few months in each year. In the closed season, ore would be stockpiled and income would cease, which had obvious drawbacks for the copper companies.

Thus his comprehensive report recommended a narrow-gauge (2' 6") tramway or light railway from Okiep to Port Nolloth. The Colonial Government did not support this solution and instead built Fletcher's Messelpad road to Hondeklip Bay. Unfortunately the Cape Copper Company was in the meantime committed to contributing to the improvement of this road, so Hall's proposal for a railway, although accepted in principle, could not be implemented at that time.

However, when in the next few years the transportation of ore by wagon went from bad to worse, the Copper Company called Hall back to carry out the necessary surveys, and to design and build the Port Nolloth railroad which he had recommended three years earlier.

It was a formidable task involving a 70 km section across the littoral sandveld to the foot of the escarpment. The Anenous Pass then climbed 400 m to the plateau over a distance of 12 km, and the final section across the hardeveld to Okiep covered 55 km. Not only did Hall have to cope with the unfriendly climatic, geological and topographic conditions, but also with a lack of trained artisans and labour, and with the continual difficulties of getting supplies and equipment delivered on time from overseas. (It should be remembered that government road builders could invoke convict labour – Hall had no such resources.) Nonetheless, he succeeded in

the coast.

In 1854 Fletcher surveyed the first 120 miles of the Orange River and brought the first thirteen bags of copper ore down the river to the anchorage on the coast on behalf of the Kodas Mine, which had hoped that this waterway could be used to transport ore. During the voyage the boat was nearly caused to capsize by a hippopotamus, and without much further ado that mode of transport was abandoned.

Fletcher's attention then turned to the Cape Copper Company operations in the vicinity of Okiep. Ore from these mines was transported along primitive tracks and across rugged terrain to Hondeklip Bay, by a motley fleet of ox wagons and mule trains. The routes – as with all unmade roads across mountains – crossed the divide at summits to avoid wagons toppling over on side slopes, but the steep climbs were viciously cruel to animals, men and wagons.

Fletcher, who had been appointed government surveyor for the region, teamed up with Thomas Hall (PM 14) to find an

answer to the transport problem. The preferred solution was a narrow-gauge railway to Port Nolloth, but for the time being that was out of the question. The Colonial Government even initially rejected Plan B, which was for a properly engineered road down the escarpment, but eventually, after sustained pressure from the mines and the community, the funds were approved. Fletcher was regraded to Inspector of Roads and put in charge of the survey, design and construction of the work.

It was a tough job, carried out by convicts supervised by 'totally inexperienced' overseers. The major feature of the route was the Messelpad Pass, built between 1867 and 1871, which is still in use in – for all practical purposes – its original form.

Despite the labour problems – and droughts and cattle sickness – the workmanship was excellent. The dry-stone retaining walls, which solved the problem of the tumbling wagons, compare favourably with those built by the Bains on better known passes further south. The pass has been declared a National Monument.

Fletcher left Namaqualand in about 1875 and settled in Cape Town where he became involved in water supply schemes to the city area, having been one of the first proponents of a dam on the top of Table Mountain and a tunnel through the Twelve Apostles to deliver water to the city.

He then moved to the Eastern Cape, designed the water supply for Queenstown, and was engineer in charge of construction of the main road to the north and the road to Port St Johns. He was thereafter appointed as Inspector of Mines for the short-lived Millwood gold field near Knysna and was involved in the development of a coal mine at Indwe. He died in 1897.

As a pioneer engineer – probably the first formally qualified engineering geologist – in a developing country, Patrick Fletcher made a significant contribution through using his varied professional skills to good advantage.

Graham Ross and Tony Murray

Photograph from Romance of the Cape Mountain Passes by Graham Ross

building a work unique in our history, and one which saved the copper mines from closure.

The complete railway was formally opened on 1 January 1876 and was in service until 1942.

The first section was brought into use using mules, and when Hall saw how well the track stood up to the carriage of materials he recommended trying a light steam engine. Two locomotives were imported, but proved unreliable, not the least because they consumed large quantities of water. The company reverted to mules and for a time kept an enormous stable of some 260 animals. Each train required about 60 mules to pull it, except on the section down the Anenous Pass, which the trucks ran down under gravity – and the watchful eye of the brakeman!

Eventually, and not without some false starts, steam was reintroduced in 1990, and served until the line was taken out of service. Road motor transport proved more efficient and gradually took over, initially to Port Nolloth and later to the SAR railhead at Bitterfontein.

The benefits of the railway were quite spectacular. In 1870, 12 000 tons of ore were mined, but only 7 300 tons could be transported to the port. In 1872, when only the coastal section was in operation,

► The Okiep–Port Nolloth narrow-gauge railway (NLSA 9487)

13 240 tons were exported. Little wonder that the company opted to extend the line!

After the Namaqualand job Hall was employed by William Brounger of the Cape Railways to find a way for the line from Worcester through the Langeberg to the Karoo, from where the location of the line to the Diamond Fields was relatively simple. His best route was via Montagu and Ladismith and then doubled back to Touws River. He spent about six months on that job, for which he was paid a mere 100 pounds. (Fortunately for the efficiency of the SAR, Wells Hood, Brounger's star location engineer, discovered a much more direct line through the Hex River valley.) During this period Hall's voice was heard in influential circles, and he is credited with having advised the Colonial Select Committee to adopt the 3' 6" (1 067 mm) gauge which has since become the standard gauge in Africa south of the Sahara.

Hall next did a flying survey from Pretoria to Lourenço Marques for President Burgers of the ZAR, and then became traffic manager of the Cape Railways at Port Elizabeth until he was



pensioned at the age of sixty. Thereafter he filled his days as manager of Thomas' Mine (near Avoca). In 1889 he was appointed by President Brand to manage the Free State railways, but he died in Pretoria while on his way to take up the post. He was then aged 66 years.

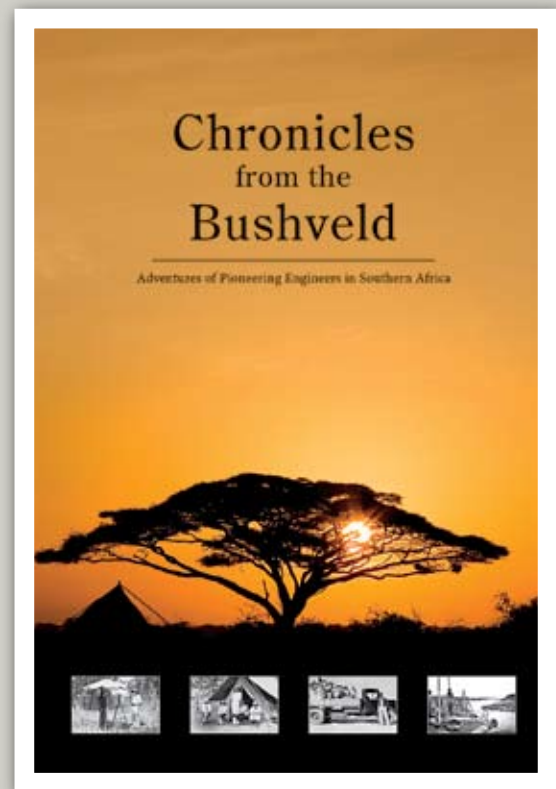
Like several of his contemporaries, Richard Thomas Hall was a bold and competent engineer whose achievements merit more appreciation than they have received in the professional annals of our country.

Graham Ross and Tony Murray

Photograph from Romance of the Cape Mountain Passes by Graham Ross

Chronicles from the Bushveld

The year 2007 marked the 85th anniversary of the founding of the Jeffares & Green Group. To mark this occasion, *Chronicles from the Bushveld: Adventures of Pioneering Engineers in Southern Africa* was published to pay tribute to the achievements of JLS Jeffares, Hal Green, and other giants of the civil engineering profession. Accounts of their early exploits were preserved in the form of diaries and letters written in the bushveld by the women who accompanied the expeditions. These 'chronicles' make fascinating reading for anyone with an interest in the veld, wildlife or history, and are all the better for having been written by non-engineers, thus avoiding the pitfalls of an overly technical focus. As such, the book is not the history of Jeffares & Green, but a celebration of civil engineering in southern Africa that can be dipped into by anyone at any time



The foundations for the firm of Jeffares & Green were laid in Johannesburg in 1922 when John Lett Sealy Jeffares began operating as Mr JLS Jeffares Consulting Practice. JLS – the name by which everyone knew him – was already 50 years old at the time. Five years later he recruited Harry Holland (Hal) Green, an engineer 32 years his junior, little knowing that this young man would one day become his partner and give his name to the other half of the present-day company.

In 1946 the company was joined by John Hawkins, and for a brief period the firm was known as Hawkins, Jeffares & Green. When the partnership was dissolved in 1947 the firm reverted to the name of Jeffares & Green – a name it has borne proudly ever since.

JLS, who led the firm until 1954, was a remarkable man. A true pioneer of surveying and engineering in Africa, he was duly recognised by the award of an OBE in the Queen's Honours List of 1955. Although he is recognised for all his work in Africa, special mention is given to surveys in Rhodesian and Nyasaland (Zimbabwe, Zambia and Malawi).

He first met Hal Green in 1927 when engaging staff to assist with a railway line from Blantyre to Lake Nyasa (now Lake Malawi). Hal was engaged as assistant engineer to JLS at the princely sum of £30 per month and in January 1927 they set off into the wild.

When the survey parties eventually reached Lake Nyasa, there was great rejoicing. JLS persuaded government officials to let them board a naval gunboat, the *Gwendolin*, for a few days, so that the conquering surveyors could sail the lake until they ran out of champagne ...

JLS retired at the age of 82 and returned to his farm in Ireland. Hal Green took over the management of the firm until he retired in 1970 at the age of 65.



- 1 Eleanor Jeffares and the Chev
- 2 River crossing by means of a pontoon

EXTRACTS FROM THE BOOK Letters from the Kalahari

'On 1st March 1931 we left on a three-month reconnaissance in the Bechuanaland Protectorate and South West Africa. I have on my personal account brought my Chev car, with my daughter, Eleanor, and Mrs Phyllis McMichael as drivers and clerical assistants. At the outset local opinion was extremely pessimistic as to the possibility of a motor car negotiating the country to be traversed. The inclusion of two women increased this pessimistic feeling, but to them it was a wonderful adventure.

'We left Palapye Road, where the party had assembled, a gay caravan of three scarlet-painted Thornicroft lorries, each laden with three tons of petrol, water, provisions and camping outfit, besides the necessary survey instruments ...

JLS Jeffares

'It really is so lovely out there, just as the sun has gone down after a lovely sunset and with the plain stretching on all sides of us dead flat for as far as one can see. We are sitting over our sundowners, in our case quinine and a good brand of cider, with the comfortable feeling that we have accomplished the worst part of our journey ...

'When I was driving today I put the car wheels into the spoor of the lorry in front of us, and fixed her at four miles an hour, and then sat back for five hours reading a novel whilst Eleanor and the wireless officer slept ...

'We now have electric light run off the car battery to hang over our dining table; it is much more satisfactory than lamps and gives a better light. On a wet night we have it over the dining table in our tent and it is very cosy and nice ...

'We cudgeled our brains for ways – waterless ways – of



3 Villagers help with a drift crossing

4 Birds such as the spurwing goose, pheasant and guinea fowl provided delicious eating

cleaning ourselves. The first night we still had one watermelon left, so rubbed ourselves with the rind, drying it off immediately, with rather harrowing results to our towels, but with very excellent cleaning effect. For all beauty specialists I give it as a most efficacious skin tonic leaving one's skin soft and velvety ...'

Phyllis McMichael

My Kariba diary

'Such were the terrors the forge inspired in the local inhabitants that Livingstone, in his travel notes, wrote: "No one ever risked his life at Kariba without first paying the river doctor or high priest for his prayers." And I confess to having said many a silent prayer before entering the gorge, and many more of thanksgiving for a safe return. Such places bring you nearer to the divine.'

Nancy Good

► ORDERING INFO

Charmagne Denny
Jeffares & Green
T 033-347-1841

Have your say

Historical information on bridge near Zastron

I was very interested in the article entitled 'Bridge reinstated to its former glory' in *Civil Engineering* 15(11).

I have a personal interest because my grandfather, George Richardson, was involved in the construction of that bridge. The family also maintains that he designed the bridge, but I'm not sure if this is true or false.

Anyway, I have a photograph of my grandfather at the bridge, which confirmed to me that it is the same bridge!

Do you have any information on the original designer of the bridge? I would like to confirm if my grandfather was the designer or

if he was only involved in its construction (as site engineer). If he were alive today he would be thrilled to see your article as he was very proud of 'his bridge'.

Although the article is excellent, I did notice one mistake. The bridge is not over the Orange River. Our family history has it that it was the Caledon River. If you check maps you'll see that the Zastron area is in the Caledon sub-catchment and that the Caledon only joins up with the Orange at a point much further down (I think near Bethulie).

Thanks for the very interesting magazine that you publish.

Irene de Moor

iredemoor@telkomsa.net

Sustainable sanitation and the use of urine diversion toilets as an acceptable solution

The Strategic Framework for Water Services, 2003, describes a basic sanitation facility as the 'infrastructure necessary to provide a sanitation facility which is safe, reliable, private, protected from the weather and ventilated, keeps smells to the minimum, is easy to keep clean, minimizes the risk of the spread of sanitation-related diseases by facilitating the appropriate control of disease carrying flies and pests, and enables safe and appropriate treatment and/or removal of human waste and wastewater in an environmentally sound manner'.

Although the word 'basic' is used in the title, the definition is in fact a set of principles that apply to any form of sanitation. Thus if a wastewater treatment works does not purify to the required discharge standard, it would not comply with the principles and should not be acceptable as a basic sanitation facility. However, this is often disregarded when comparing waterborne sewage to other systems.

An example of this appears in the October 2007 issue of *Civil Engineering* where it is stated in the article 'Upgrades in Eastern Cape under way' that pit latrines and VIPs (essentially the same system) would pose epidemic threats like cholera, will contaminate the groundwater and will in turn pollute the adjacent rivers. Unless there is rock within 1 m



Another problem with waterborne sewage is the extraordinary disconnection between people flushing the toilet and the blocked manhole in front of their houses. Somehow they do not connect the two. Only when the blockage occurs on their property do they understand how their actions caused the problem

of the surface or the pit actually penetrates the groundwater this is untrue, and it is an acceptable form of sanitation.

Any form of sanitation system requires human intervention.

- Waterborne sewage requires people to operate and maintain the reticulation and the treatment works. Blockages in the reticulation are particularly messy to deal with and whilst they occur, pollution of the environment occurs. Many of South Africa's treatment works are failing to meet the discharge standards with the resultant decrease in surface water quality, yet somehow this is acceptable whereas the far more minimal pollution from a pit type toilet is not
- VIPs require emptying of the pit when full or moving the structure to a new pit. This second option was the preferred method of rural people until government intervened and specified brick toilets that cannot be moved. eThekweni, which has 33 000 brick VIPs, has found it very difficult to empty them. Currently they are experimenting with a programme of manual emptying, which often involves people physically getting in the pits. The University of KwaZulu-Natal has found this poses very high health risks to the workers
- Bucket toilets function well if the bucket is emptied every day between about 9 am and 10 am. (This was the practice in areas such as Johannesburg before waterborne sewage was installed.) However, it requires cheap labour to be effective. In South African townships this has not been the case with the buckets being emptied up to once every two weeks. At this stage, in hot weather they stink to high heaven and because they are often full to the brim it makes them difficult to remove without spilling. The smell is worse than a sewer and can permeate the entire area, making it very unpleasant for both the households and the workers. Human intervention is required for the removal of the buckets and the treatment of the sewage
- Urine diversion toilets need the removal of the faeces and the bulking agent on a regular basis, which is then composted to render the faeces harmless. Only solids

are removed making it far easier to handle than a bucket which contains urine as well. Composting can take place on site or at a central facility

About the only option that does not require human intervention is a VIP that is always moved to a new hole. For this option to work you need a very large garden or you will eventually get back to an area that contains decomposed faeces.

Another problem with waterborne sewage is the extraordinary disconnection between people flushing the toilet and the blocked manhole in front of their houses. Somehow they do not connect the two. Only when the blockage occurs on their property do they understand how their actions caused the problem.

If waterborne sewage is unaffordable, then in South Africa there are two technologies that have been widely promoted: VIPs and urine diversion toilets.

It must be noted that neither of these systems deal with greywater, which is a problem in dense urban areas. Urine diversion has been combined with greywater recycling on a 500 m² plot in Johannesburg and houses in Canarvon and Sutherland, but not in very dense areas.

VIPs work by anaerobically digesting the faecal matter whilst the liquid fraction seeps into the surrounding soil. The smell is drawn out of the pit by the ventpipe. Sludge gradually accumulates in the pit and when it is full it must be emptied or a new toilet built. Rapid pit filling is found when the pit is also used for refuse disposal. eThekweni switched from VIPs to urine diversion toilets as they could not sustain VIPs. VIPs cannot be used in areas of hard rock, high water table or placed inside a house.

To overcome the problem of long-term sustainability Amathole District Municipality are considering the idea of two pits about 2 m apart – the top structure will be moved over 1,5 m deep and the households will be encouraged to throw in other organic material to encourage composting whilst the pit is not in use. When the second pit is full the household will need to dig out the com-

posted contents of the first pit for the system to be sustainable.

Urine diversion toilets work by separating the urine from the faeces. The urine is lead to a soakaway outside the toilet and the faeces drops into a shallow chamber underneath the toilet. Dry soil is added for bulking and odour control. If the dry soil is used correctly a ventpipe is not required and this greatly improves the comfort of the toilet.

In South Africa two variants are used: the double-pit system in eThekweni and the single-pit system virtually everywhere else. For either system to work properly it essential that the contents of the chamber be kept dry. If it gets wet, it tends to decompose anaerobically and smell.

In the double-pit system, after the first chamber is full (normally one year) the toilet is switched to the second chamber. When this is full, the first chamber is emptied and the contents buried alongside the toilet where composting in the soil will occur. In the single-pit variety the chamber is emptied frequently and the contents composted aerobically. In both cases simple garden tools are required (spades and rakes) and the contents is solid, not liquid.

As with VIP toilets, there have been many problems as a result of incorrect implementation and lack of long-term support to solve problems when they arise. The notable exception to this has been eThekweni, who have provided continuous support to households and retrofitted when problems arose.

The contents of a urine diversion toilet does not compare with that of a bucket toilet. Whilst that of a urine diversion toilet is solid and does not smell if kept dry in the chamber, a bucket is liquid and stinks. When it is aerobically composted, no smell is noticeable.

The author has personally taken the fresh contents of a urine diversion toilet into the Presidency at the Union Buildings, into Parliament, through O R Tambo Airport (at one stage he flew with it as hand luggage in the cabin to Durban), had it in toilets on the exhibition floor at the World Summit on Sustainable Development, Rand Show, Insite and numerous workshops. No-one has noticed. He has also had over 1 000 visitors through his house where there is a urine diversion toilet en suite to the main bedroom. The first reaction of visitors on seeing the toilet is to exclaim that it does not smell. They also do not notice the composter 2 m from the front door.

In 2001, when the White Paper on Basic Household Sanitation was approved, DWAF included in the technical handouts informa-

tion on urine diversion. It has, therefore, being accepted as fulfilling the requirements of a basic sanitation facility as described in the Strategic Framework for Water Services.

Acceptance of urine diversion (and VIPs in some areas) has not been easy and certain conditions apply:

- If members of the household are being expected to handle their faeces, free waterborne sewage must not be provided within the same municipality, or there must

be an incentive to adopt urine diversion (or for that matter VIPs). If not, it is perceived as inequitable treatment

- The household must be given a choice. Inevitably, where a VIP is possible it has been found that this is the first choice. Only when physical conditions such as hard rock on the surface or a high water table occurs do people readily consider urine diversion as an alternative
- Long-term support is required as this is a

new technology and people do not know how to solve the problems

- Designs must be done by competent people (those who have implemented successful projects before). Too often failure occurs because designers have never used the product. A classic example is use of concrete lids at the back that are too heavy to move, thus rendering the toilet unsustainable

Richard Holden

Date	Event and CPD validation number	Presenters/venue	Contact details
3–4 March – Bloemfontein 10–11 March – Cape Town 13–14 March – Pietermaritzburg 17–18 March – Durban 7–8 April – East London 10–11 April – Port Elizabeth	Project Management and the Law – Practical Guidelines for Management of Engineering and Building Contracts	Tertius du Toit	Carla de Jager registration@carlamani.co.za
12–18 April – Sandton 7–13 June – Cape Town 21–28 June – Sandton 6–13 September – Bedfordview 1–7 November – Bedfordview 26–12 December – Bedfordview	The Application of the Finite Element Method in Practice SAICEstr06/00018/08	Roland Prukl	Dawn Hermanus dhermanus@saice.org.za
19 March – Cape Town 2 April – East London 23 April – Port Elizabeth	Structural Steel Design to SANS 10162-1:2005 SAICEstr06/00050/09	Greg Parrott	Sharon Muger cpd.sharon@saice.org.za
11–12 March – Cape Town 27–28 March – Durban 8–9 April – East London 29–30 April – Port Elizabeth	Technical Report Writing SAICEbus06/00014/08	Les Wiggill	Sharon Muger cpd.sharon@saice.org.za
3–4 March – Polokwane	Soil Stabilisation SAICEtr06/00023/08	G Selby	Dianne Sarfuse1@acenet.co.za
14–15 April – Pietermaritzburg 12–13 May – Cape Town 17–18 July – Durban	Handling Projects in a Consulting Engineer's Practice SAICEproj06/00003/08	Wolf Weidemann	Dawn Hermanus dhermanus@saice.org.za
4–7 March – Johannesburg 15–18 April – Durban 6–9 May – Cape Town	Project Management SAICEbus07/00252/10	Tony Lydall	Sharon Muger cpd.sharon@saice.org.za
17–18 April – Pietermaritzburg 15–16 May – Cape Town 14–15 July – Durban	Business Finances for Built Environmental Professionals SAICEfin06/00004/08	Wolf Weidemann	Dawn Hermanus dhermanus@saice.org.za
18–22 May – Sun City	WISA 2008 'The Confluence of the Water Industry' ProvSAICEwat07/00154/08	www.wisa.org.za	Melissa Wheel wisa@wisa.org.za
24–26 November – Cape Town	2nd International Conference on Concrete Repair, Rehabilitation and Retrofitting	www.civil.uct.ac.za/iccrrr	iccrrr@eng.uct.ac.za +27-21-689-7471

For more information on courses, venues and course outlines please visit <http://www.civils.org.za/courses.html> or contact cpd.sharon@saice.org.za