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INNOVATION, ADAPTATION AND ENGAGEMENT IN A CHANGING WORLD

**An assessment by engineering professionals of the  
condition of infrastructure in South Africa**

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*In 2006 the South African Institution of Civil Engineering (SAICE) released the first ever “report card” of the state of engineering infrastructure in South Africa. This report highlighted “the observations of the professionals responsible for the planning, construction, operation and maintenance of our nation’s life-support system”. It graded infrastructure on a scale from A+ through E-. The purpose of the report card was to draw the attention of government, and of the public at large, to the importance of maintenance, and to factors underlying the state of repair of infrastructure. The success of this report card was such that SAICE, with the assistance of CSIR, has prepared the next report card, to appear early in April 2011. It is anticipated that this next report card will be even more widely debated, because, since 2006, service delivery problems, particularly those attributable to operation and maintenance of infrastructure, have received heightened attention across the country.*

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**Introduction**

Report cards are reflections at points in time on the state of built environment infrastructure, i.e. that part of the nation’s public sector capital stock producing services consumed by households, such as hospital services, drinking water, sanitation, electricity, or which facilitates economic activity, such as electricity, roads and ports. This infrastructure is a public asset. All citizens have a stake in its upkeep and operation, and all share in the expense of its construction and its ongoing maintenance.

Well-maintained infrastructure underpins quality of life and economic development. If maintenance is inadequate, social and economic growth will be impeded. The compilers of report cards intend them to be instruments to contribute to better-informed decisions on infrastructure development and maintenance. Thus the purpose of report cards is to draw the attention of government, and of the public at large, to the importance of maintenance, and to factors underlying the state of repair of infrastructure – factors such as skills and finance, for example.

While the link between engineering infrastructure and economic growth may be clear, it is not always obvious that a similar link exists with social health. It is obvious, though, that cleaner drinking water, proper sanitation, better shelter, access to transport and electricity, all improve the quality of life. There is an old saying that somebody pays for maintenance, whether it is done or not. The consequences of neglect are severe, affecting the very lives of people, through outbreaks of waterborne disease, reduced safety on roads and rail, inconvenience and inefficient commercial activity. Research by the South African Institution of Civil Engineering (SAICE) indicates that, in general, developing countries have more doctors than engineers, whereas the opposite is true in developed countries. The inference can be made: proper infrastructure prevents disease and sickness.

Neglect is also costly in financial terms - for example, roads maintenance that is delayed for one year could cost three to six times more when there is eventually no choice but to do it. The saying "a stitch in time saves nine" holds true even in the context of engineering infrastructure!

## **International practice**

One of the earliest “report cards” on infrastructure was produced in the USA in 1988 by its National Council on Public Works Improvement. Ten years later the American Society of Civil Engineers (ASCE) produced its first “Report Card on America’s Infrastructure”. Since then, it has released a new report every second or third year. The reports have gradually become more detailed and broader in scope so that now reports are produced for many of the individual states and, in some instances, counties.

ASCE has also produced an action plan appealing to Congress for such actions as establishing a National Commission on Infrastructure, increasing funding for specific improvements and promoting appropriate legislation. The ASCE initiative is well funded and is an integral part of the lobbying process that is so much a part of American public participation culture.

In the United Kingdom, the Institution of Civil Engineers (ICE) has more or less annually since 2000 published a “State of the Nation” Report. The report is compiled each year by a panel of experts drawn from the various fields of civil engineering expertise across ICE’s membership. Its aim is to stimulate debate and to highlight the actions that civil engineers believe are needed to improve the state of the nation’s infrastructure. The report is issued to a wide audience of stakeholders, including politicians, civil servants, local authorities, trade, regulatory and consumer bodies as well as the media.

ICE, like ASCE, has progressively elaborated its product to regional reports, and has made the grading more sophisticated by incorporating trends and sustainability aspects.

In the preface to the 2010 Report, ICE President Paul Jowitt asked:

*“What is the state of our infrastructure? Is our infrastructure being taken for granted? Is the UK falling behind its global competitors? And is society being put at risk?”* (ICE 2010, page 2)

He continued:

*“Infrastructure is vital to our way of life. It is vital to society. It is vital to economic growth in an increasingly competitive world. It is vital to the environment. And it is vital to the very existence of a civilised society. If we don’t invest in critical infrastructure now, we will face severe consequences in the future. We must revive our infrastructure to make it fit for the 21st century, and not remain dependent on ageing assets”.* (Ibid)

In 1999, Engineers Australia produced a national Infrastructure Report Card which addressed three categories (roads, rail and water). 2003 and 2005 report cards increased the number of categories to seven. Engineers Australia has also subsequently produced State and Territory report cards. The next national report card is currently being prepared.

In all the cases cited, the intention has been for engineering professionals, in the manner of “expert witnesses”, to provide the public with a professional opinion on the condition of infrastructure. The media reception has at times been sensationalist, and the reaction from much of the public sector has ranged from full agreement through to strong denial. By contrast, reception of the first SAICE report card in South Africa can only have been described as “mature”.

## **The 2006 report card**

Late in 2006, SAICE, utilising desktop research documentation prepared for the specific purpose by the Council for Scientific and Industrial Research (CSIR), taken together with at that time unpublished research by Lawless and by Amod, released the first ever “report card” of the state of engineering infrastructure in South Africa. This report highlighted “the observations of the professionals responsible for the planning, construction, operation and maintenance of our nation’s life-support system”. (SAICE 2006) It graded infrastructure (water, sanitation, solid waste, roads, airports, ports, rail, electricity and hospitals and clinics) on a scale from A+ through E-.

The process intentionally did not comment on the legacy that gave South Africa an imbalanced distribution of infrastructure. The past cannot be managed - only the present can be managed, in the hope and with the objective of creating a brighter future. Since 1994, huge strides have been made by the democratic government to correct this imbalance. Ambitious plans have been made and implemented. Drinking water, sanitation, energy and transportation access have received focused attention, and, acting on its mandate, the government is continuing to invest at rapid pace in infrastructure for disadvantaged communities.

The report also did not make any comment on levels of service, or of technologies - for example as to whether they might be appropriate or inappropriate. Nor did it take into account stated intentions of many agencies to improve infrastructure in the future - intentions need to be implemented, and this implementation will be reflected in improved grades in future report cards. The focus was entirely on the then current condition of infrastructure.

The 2006 report itself is available on the SAICE website ([www.civils.org.za](http://www.civils.org.za)), so all that is reproduced in this paper is a table (below) of the grades for one of the infrastructure sectors, with brief explanations.

<b>Table 1. Selected gradings: 2006</b>		
<b>Water</b>	<b>C+</b> for major urban areas	South Africa is one of few nations where in most urban areas water can be drunk directly from the tap. Major, and ongoing, strides in provision of water and sanitation since 1994. However, erratic compliance with water quality requirements in most municipalities. Water wastage (leakage) is much too high. Shortage of skilled personnel.
	<b>D-</b> for all other areas	
<b>Sanitation (including wastewater)</b>	<b>C-</b> for major urban areas	Serious problems with management of many wastewater (sewage) treatment works. Wastewater leakage and spillage much too high, and frequent problems with on-site sanitation. Inadequate operation and maintenance capacity, and shortage of skilled personnel. Major urban areas grade is pulled down by Cape Town and Sebokeng.
	<b>E</b> for all other areas	

The overall grade given for built environment infrastructure as a whole:

<b>Table 2. Overall grading: 2006</b>		
<b>Overall Grade</b>	<b>D+</b>	Although South Africa's built environment infrastructure is very good, even world class in parts, the relatively poor overall grade reflects extensive maintenance and refurbishment backlogs. These backlogs are caused primarily by funding and skills shortages.

The intent was to inform the public and decision makers (who are generally lay-people when it comes to technical matters), about the importance of infrastructure in their daily social and economic intercourse, by highlighting the current status of its condition. It was hoped that enhanced awareness would lead to better informed decisions with respect to maintenance management and planning for new expenditure.

The following were the primary achievements:

- For the first time ever in South Africa (or, for that matter, in Africa), a consolidated report on the state of a broad range of infrastructure nationally was published by a credible institution, drawing attention to its condition and importance, and headlining issues requiring attention in a manner understandable to technical, decision-making and lay persons.
- The primary objective of informing the public and decision makers was very successfully achieved if the numerous live interviews and presentations, print, visual and audio media exposure and discussions with infrastructure owners and sector organisations can be taken as any kind of indicator.
- The exposure received by SAICE was the greatest it had received in many years, if not ever, all of it overwhelmingly positive. The credibility of the Institution as a learned society with the authority, indeed the duty, to comment broadly on engineering infrastructure was undoubtedly enhanced.
- Invitations were received from government departments and others for SAICE to engage with them in order to address issues raised in the report card.

- Building on and reinforcing the message from the excellent work done by SAICE Past-President Lawless in the SAICE Numbers and Needs project (Lawless 2005 - and, subsequently, Lawless 2007), the awareness of the public, parents, learners, educators and government to the urgent need to pay more attention to and devote more resources to infrastructure matters, and to the need for more and better skilled engineering practitioners.

Did the report card lead to better informed decisions being made with respect to maintenance management and planning for new expenditure? That, it was agreed, would be impossible to gauge except indirectly, such as in the results of the next report card, and in particular any trends revealed thereby.

### **The 2011 report card: overview**

In the euphoria following the good reception of the 2006 report card, SAICE entertained thoughts of expanding the scope of its next report card - such as more detailed analyses of one or more province (South Africa has nine), or of a sector, such as all municipalities. Also suggested was extending the process to neighbouring countries. However, as was acknowledged at the time, "Clearly, these are ambitious objectives and some, if undertaken, go beyond the mandate of SAICE and will require external authority and especially substantial funding." (Amod and Wall 2007)

Deliberately left undefined was the publishing interval. Infrastructure condition does not alter significantly in the space of a year, so it would not be cost-beneficial to undertake another report card for at least three years. When the next report card should appear was a decision that could safely be left to future SAICE leadership.

In 2009 the decision was taken that, whereas so much construction had been taking place in preparation for the 2010 FIFA World Cup, the next report card should only be published after the Cup. This would allow a reasonable period for the new infrastructure to be used before it was graded. In making this decision it was fully appreciated that primary research findings inevitably lag reality - that is, several months have ordinarily passed by the time research findings become available. Thus research is inevitably at the very least to that extent out of date by the time that it can be used.

Budgetary constraints, also, led to a cutting back on ambitions with respect to the coverage of the report card. It was in the end decided that the objectives would best be served by:

- Adhering to the same sectors covered in 2006 (viz water services (including sanitation and wastewater) and resources, solid waste, roads, major airports, major ports, rail, electricity, and hospitals and clinics), and adding only schools.
- Highlighting trends since 2006 (improvement, decline or unchanged grades since 2006), and possibly making comments on stability or "resilience" (i.e. the prospects of infrastructure in the sector receiving the maintenance and refurbishment needed in order to continue to perform at least at the level indicated by the grading now given).
- Ensuring that the process of grading would be more rigorous than that in 2006, with greater consultation and finer definition of the process and particularly the grading.

On the latter point: as mentioned earlier, SAICE was taken aback (and felt somewhat complimented) by the ready public acceptance of the gradings given. That is, there was hardly any criticism or attack on the gradings, or even a questioning of them. There was not a single call for SAICE even to name the research upon which it had relied - never mind calls for that research to be made available.

However that was in 2006. Since then, the issue of generally reported deteriorating infrastructure in some areas has come much in the public eye. It has also become much more political than before. Some sector infrastructure owners have proven very sensitive to criticism, irrespective of whether they perceive it to be fair or unfair.

The water services sector has received particular attention, in political circles, in the media, and in the eye of the public (for example CDE 2010). The sterling efforts of the Department of Water Affairs (DWAF, now DWA) in undertaking the Blue Drop (assessment of drinking water quality in all municipalities) and Green Drop (assessment of wastewater treatment works in all municipalities) analysis processes, and releasing the reports to the public domain (DWAF 2009, DWA 2009, DWA 2010), have set a good example to the sector leaders of other infrastructure sectors, and, rightly, have been highly praised.

The critical importance of the local government sphere, with its considerable responsibilities for, among other things, service delivery, has been recognized by national government, as has the need to "turn" many municipalities "around". (CoGTA 2009, CoGTA 2010)

For all these reasons, SAICE has no doubt that the process of gathering and analysing research, and the subsequent process of allocating the gradings, had this time to be not just more rigorous in itself, but also more rigorously documented - in case it is queried. Trends, especially, will for sure be interrogated.

SAICE once again recognized that the CSIR is the organisation that is best able to assemble and analyse the body of data required - as indeed was the case in 2006. Thus an understanding was reached between SAICE and CSIR that CSIR Built Environment would prepare research reports in respect of each of the specific infrastructure sectors. (Note 1.) This the CSIR did. SAICE thereafter prepared the report card as such, soliciting, as part of the process, input from its extensive membership of infrastructure professionals. On April 5 SAICE will launch the report. (For that reason, while this paper describes the process of preparation of the 2011 report card, issues underlying the present state of the infrastructure, and the 2006-2011 trends, the actual grades awarded cannot be revealed until April 5.)

The 2011 grading was first done within each infrastructure sector. Thereafter, considering all the gradings across all sectors, SAICE carried out a process whereby the grades across all sectors were assessed. Grades were then adjusted - this process of adjusting grades was a systematic one. The meaning of "B" for airports and "B" for roads, for example, were compared, and considered in the light of higher order principles such as what constituted functionality, and what were its implications. Some grades were adjusted, some slightly upwards and some slightly downwards, to facilitate consistency of interpretation throughout the report. In this systematic way, a balanced result has, it is trusted, been achieved.

The question was asked: what is "fair", and hence deserves to be graded at the midpoint (i.e. "C")? Overlain on this concept of a grade of "fair" are the dual questions of:

- below what grade is the condition of the infrastructure in that sector hampering its functionality - or even severely or maybe completely preventing it from functioning? And
- to what extent could particular elements of infrastructure within a sector be critical to its functionality, and how to express that in a grading?

Table 3 reflects SAICE's decision on this.

<b>Table 3. Meaning of grades: 2011</b>				
<b>"A"</b>	<b>"B"</b>	<b>"C"</b>	<b>"D"</b>	<b>"E"</b>
<b>WORLD CLASS</b>	<b>FIT FOR THE FUTURE</b>	<b>SATISFACTORY FOR NOW</b>	<b>AT RISK</b>	<b>UNFIT FOR PURPOSE</b>
Infrastructure is comparable to the best internationally in every respect. It is in excellent condition and well maintained, with capacity to endure pressure from unusual events.	Infrastructure is in good condition and properly maintained. It satisfies current demands and is sufficiently robust to deal with minor incidents.	Infrastructure condition is acceptable although stressed at peak periods. It will need investment in the next few years if serious deficiencies are to be avoided.	Infrastructure is not coping with demand and is poorly maintained. It is likely that the public will be subjected to severe inconvenience and even danger without prompt attention.	Infrastructure has failed or is on the verge of failure, exposing the public to health and safety hazards. Immediate attention is required.

In awarding grades, it was realised that the utility of the infrastructure could be determined by more than the physical condition of the infrastructure. For example:

- The physical condition of a facility might be good, but the facility is not usable because of staff skills shortages, or there is no equipment.

- The infrastructure might not be "fit for purpose" - for example, it is in a good physical condition, but is the wrong type of structure, and/or in the wrong place, and/or technologically obsolescent, and/or overloaded (technical obsolescence is more frequently encountered in respect of mechanical and electrical infrastructure than it is for civil engineering infrastructure).
- The infrastructure might be in good physical condition, but operation is hampered by frequent shortages of raw materials (e.g. fuel, chemicals).
- Productivity and operational inefficiencies retard the utility of the infrastructure - i.e. the infrastructure isn't delivering as it should, not because of the state of the infrastructure, but because of other factors: such as inefficient scheduling, underutilisation of assets, etc, that together constitute this operational inefficiency.

The research team commented on all of these issues, and flagged concerns, but based the gradings on the physical condition only.

The gradings deliberately do not take account of intentions - even if these are in the form of programmes, with budgets. The report card is strictly focused on the current situation. In other words, what infrastructure owners say they are going to do in order to rectify or improve the current situation is not taken into account this time round. SAICE wants to see implementation, and its results, before account is taken of plans or programmes.

### **Findings: 2011**

Averaging across all sectors, there has been marginal improvement since 2006 in the overall condition of infrastructure, influenced by the heavy investment in, especially, national assets: ports, rail, airports and national roads. However, this must not be perceived as a blanket improvement. On the contrary, the quality and reliability of basic infrastructure serving the majority of citizens (e.g. water and sanitation) is in too many instances poor and getting worse. Urgent attention is required to stabilise and improve these. That the grades for some sectors have held up since 2006 is primarily because of the rate of new construction. Sadly, however, little maintenance has been done and, were it not for the large capital investment of the last five years, the overall trend would be downwards.

Two key themes run as a thread through all the 2011 grades, as they did in 2006. The first is the great shortage of skills, especially away from the major metropolitan areas, and the impact of this deficit on planning, procurement, design, construction and care of infrastructure. The second is the inadequate funding of maintenance of the existing asset base and the new assets that constantly come on-stream. The allocation of maintenance funding is with very few exceptions simply not sufficient, especially in circumstances where it was expected to also cater for a maintenance backlog, requiring upgrading, repair or refurbishment in addition to routine maintenance.

To reiterate: the report card highlights that South Africa suffers an acute skills shortage in the infrastructure sector. Two statistics, underpinned by SAICE research, illustrate this:

- More than one-third of the 231 local municipalities do not have a single civil engineer, technologist or technician. Vacancies in local government for engineering practitioners exceed the 1000 mark.
- South Africa has only half as many engineers as doctors. By comparison, Australia, America, Western Europe and even China or India, have similar numbers of engineers to doctors, or more engineers than doctors. The ratio of population to engineer in South Africa is of the order of 3 200 to 1, twenty times less than some of the countries just mentioned. Furthermore, while the ratio amongst the South African white population is approximately 300 to 1, similar to America and Western Europe, the ratio in the black population is in the order of 50 000 to 1, amongst the worst in Africa, never mind in the world. The case for transformation, starting with fixing the basic education system, cannot be clearer.

Two new key themes emerged in 2011, viz. sustainability and the need to view service delivery holistically. Infrastructure, once created, is unrelenting in its demand for maintenance and this demand will increase the longer it is ignored. Skills constraints notwithstanding, bold leadership and effective management are irreplaceable ingredients for successful and sustainable infrastructure provision.

It was stated above that, since 2006, some sector infrastructure owners have shown themselves to be very sensitive to criticism, irrespective of whether they perceive it to be fair or unfair. One of their "defence mechanisms", it seems, has been to restrict access to information. The research team has found that an unfortunate result of this has been reluctance on the part of professionals in certain areas to as readily share

information with the team as was the case in 2006. Given this, the contribution to be made by the SAICE members active in these sectors assumes even greater importance.

A disappointing finding - but it must be made clear that this is in respect of a minority of the infrastructure sectors - has been the discovery that less monitoring is taking place of the state of infrastructure than was the case even a few years ago.

On the other hand, it is pleasing to report that condition monitoring has greatly improved, both in breadth of coverage and in quality, in respect of at least one sector - viz the water services sector. (Especially in terms of the Blue Drop and Green Drop analysis processes, as noted above.)

## Conclusion

While government should not change its drive to provide new infrastructure to address backlogs, the challenge is to supplement this by at the same time also focusing on the maintenance of both new and old infrastructure. If this is not done, the already considerable legacy of infrastructure that is dysfunctional for want of sound operation and adequate maintenance in the past, and that therefore needs rehabilitation or replacement at considerable cost, will increase rapidly.

Engineering infrastructure and the institutions responsible for its operation and maintenance are at the centre of service delivery. People want efficient services, and realisation of promises made to them by national and local leadership. Infrastructure that is in poor condition, or for any other reason does not deliver, hampers efforts to reduce inequality, alleviate poverty, and build a sound economy - all principles enshrined in the national Constitution

As a developing nation, South Africa's engagement in the global economy is constrained by its infrastructural capabilities. The challenges posed in this report card are no less acute because they are chronic, but they can be overcome given the same dedication and ingenuity applied to the challenge of the World Cup. SAICE hopes that the report card and discussions arising from its release will provide impetus for such action.

SAICE views it as its duty to report and engage constructively and without hesitation for the benefit of South African society. Leadership requires that SAICE, and the engineering profession, act not just as a means of fulfilling society's demands for infrastructure. Rather, SAICE must advise society regarding the wisdom and sustainability of its requirements so that the prosperity, and indeed survival, of future generations is not compromised.

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## Notes

Note 1: CSIR covered costs of the research reports, whereas SAICE covered its costs, including costs of preparation and publication of the eventual report.

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