

ROAD BUILDING AND THE ENVIRONMENT

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OPSOMMING

Met die tegnologiese vooruitgang wat die industriële revolusie meegebring het, is die mens se beskouing van die natuur met die loop van tyd verander. Soos wat die samelewing verander het, moes die natuur dadelik aanpas en het die omgewing die knie moes buig voor die mens se kapitalistiese en industrialisasiebehoefes. Die bou van paaie en treinspore teen die einde van die negentiende eeu het byvoorbeeld getoon hoe geweldig het die mens se beskouing van die natuur verander om aan te pas by die diktering van die industriële ontwikkeling. 'n Vergelykende studie van die bou van paaie deur twee omgewings sensitiewe areas in twee verskillende gedeeltes van die wêreld: die Glenwood Canyon in Colorado in die VSA en die Tuinroete in die Suid-Kaap in Suid-Afrika, lewer verskeie interessante insigte, veral omdat beide snelweë opgegradeer is in 'n tydperk toe omgewingsake 'n sleutelrol in infrastruktuurontwikkeling begin speel het. Uit die navorsing blyk dit duidelik dat die verskerpte omgewingsbewustheid 'n leidende rol gespeel het in die beplanning van albei die paaie.

Daar lê 'n verpligting op historici om hul stem te voeg by dié van andere uit ander dissiplines om die omgewingsdebat te stimuleer. 'n Bestudering en beskrywing van die geskiedenis van mense en gebeure is onherroepelik gekoppel aan die omgewing waar dit plaasgevind het. 'n Dokumentering van sodanige geskiedenis is om 'n stem te gee aan die stemlose omgewing.

INTRODUCTION

In 1964 the construction of the I-70 through Glenwood Canyon in Colorado in the United States started with twin tunnels just east of Glenwood Springs. By 1967, nearly two miles (3,38km) of freeway had penetrated the canyon¹. The National Environment Policy Act (NEPA) changed all this. It was a defining moment not only in the history of the Canyon, but in that of environmental movements in the United States and abroad. Environmental Impact Statements (EIS) were now required for federally funded projects, the I-70

J. L. Haley, *Wooing a harsh mistress*, 1994, p. xv.

through Glenwood being just one example. The EIS that was developed for the route between Glenwood Springs and Gypsum was the first of its kind for a highway project in Colorado² and ultimately the design and structure of the highway were dramatically affected. One of the results of the NEPA for the I-70 was that the planning and design of the highway was now open to public scrutiny and discussion.

In October 1984 construction on the N2 route in the Southern Cape in South Africa, past the Wilderness and along and over the Kaaimans River, came to an abrupt halt. The Kaaimans Action Group's challenge to the contractor, and the subsequent delay, conflict, and involvement of the Ministers of Transport and Environmental Affairs in the building of this road in this area, is indicative of the environmental impact concerns with infrastructural development that fanned out from the NEPA in the United States.

In 1785 James Hutton, known as the father of geology, first put forward the theory that the earth was alive.³ This idea was followed in 1891 by J. Mills, a political thinker, who challenged the assumption that humankind was entitled to the unlimited exploitation of the environment.⁴ It was however only in the 20th Century that people really started to awaken to the fact that they lived in a finite world.⁵ The time had arrived for the Biblical mandate for people to have dominion over and subdue the earth,⁶ to be revisited. Perhaps it needed deep ecologists (modern environmentalists who stress that the people's place in nature is that of a species among species) to argue that the rights of humans were no more and no less than those of any other species in a biocentric democracy, for attention to be squarely focused on environmental degradation and the impact of human activity.

The people of precolonial times have traditionally appeared to be more in 'harmony' with nature. Ironically, perhaps, this was more due to the fact that nature was seen as something to be held in

² Ibid. p. xvi.

³ J. Young; *Post environmentalism* (1990), p. 121.

⁴ Ibid., p. 65. Young cites J. S. Mills, *Principles of political economy* (1891) as an example.

⁵ Young, *Post environmentalism*, p. ix.

⁶ Genesis 1:26-28.

awe, and that the marks people left were merely superficial scars. The indigenous people of these times did not in fact have the technology, vision or need to scar nature any deeper.

However, during the process of colonization, people were not only obsessed with clearing the land, removing the vision-obscuring trees and bringing light into darkness,⁷ but with subjugating the indigenous people and nature and with putting both to their own use. The 'wilderness', defined in 1962 by the Outdoor Recreation Resources Review Commission in the United States, as areas over 100 000 acres (40 000 hectares) "containing no roads usable by the public" and showing "no significant ecological disturbance from on-site human activity",⁸ hemmed in people, frustrating their vision. It was most certainly not only the Americans, who for most of their history, regarded the 'wilderness' as a moral and physical wasteland fit only for conquest and fructification in the name of progress, civilization, and Christianity,⁹ but it also seems to have been a more colonial and expansionist mindset. Indigenous people and nature were once again on the receiving end. However, up until the late 19th Century nature was still held in some semblance of awe, this perhaps because it needed so great an effort on the part of people to 'conquer' nature. Achievements that displayed people's skill (e.g. road building through very difficult terrain) were hailed as such, 'conquering nature'.¹⁰

With the technological advances that went along with the Industrial Revolutions, and the building of roads and railroads towards the end of the 19th Century and early into the 20th Century, people's view of nature changed. People were 'progressing', civilization was 'advancing', and now a more extensive and extractive economic mode was seen to better serve their capitalistic and industrial needs. A postcolonial era was now fast approaching. Yet nature was now even to a greater extent seen as something to colonize (conquer and subdue). What was more disturbing was that the attendant attitude was changing. No longer was it such a

⁷ R. Nash, *Wilderness and the American mind* (1973), p. x.

⁸ *Ibid.*, p. 5.

⁹ *Ibid.*, pp. x and xv.

¹⁰ See footnote 30 below.

challenge to 'overcome' nature — 'technology' took care of that. The result of all this was that the respect (awe) that once attended people's work in nature was lost. As far as civil engineering, and particularly road building is concerned, the 'cut and fill' (discussed later in the essay) method used in building roads marked the nadir in engineers' relationship with nature.

Environmental problems have been with people for a long time, from the Industrial Revolution era through the process of urbanization, to the technological quantum leap of the 20th Century, and into the postcolonial period. It was the US Federal government that took the lead in this latter period in environmental control issues with the passing of the NEPA in 1969. From this, interest in environmental issues and their control spread to other developed and developing areas of the world. Generally, attention focused on industrial pollution control and the preservation of scenic and ecologically sensitive areas. These environmental problems were seen as something that planning controls and new legislation could cure. Little thought was given to wider issues like sustainable development or the dynamic and changing nature of the environment, or postcolonial environmental issues.¹¹ Most legislation has also been reactive.

Most research work flowing from the NEPA concentrated on the USA and Europe. South Africa largely followed suit in adopting standards, procedures and legislation, generally ten to fifteen years behind. In 1982 the Environment Conservation Act (ECA) was passed in South Africa, establishing the Council for the Environment.¹² A study was then commissioned by them into the possibility of having an Environmental Impact Assessment (EIA) on all planned engineering projects. In terms of NEPA a compulsory disclosure element (Environmental Impact Statement — EIS) was already required in 1970 in the USA.¹³ Nonetheless, awareness in South Africa was becoming more focused, particularly at the sym-

¹¹ R. D. Beaumont and M. B. Dold, "Third World development and the environment", *Civil Engineering*, 1, 5,(1993), pp. 15—18.

¹² J. Clarke, "Civil engineers and the environment - a frank and irreverent look", *The Civil Engineer in South Africa*, 26, 9, (1984), p. 417.

¹³ E. J. Hall et al, "Environmental protection: a practical procedure", *The Civil Engineer in South Africa*, 22, 5, (1980), p. 129.

posium on 'Engineering our Environment' held at the Rand Afrikaans University of 5 June 1984. This symposium was a collaborative venture held by the Federation of Societies of Professional Engineers (FSPE), the Habitat Council and the Environmental Planning Professions Interdisciplinary Committee (EPPIC).¹⁴

A study of road building through two environmentally sensitive areas in different parts of the world, Glenwood Canyon in Colorado in the United States, and the Garden Route in the Southern Cape in South Africa, thus makes for an interesting comparison, especially due to the fact that both of these highways were upgraded during the period when environmental concerns with infrastructural development became key issues.

ENVIRONMENTAL ISSUES IN THE HISTORY OF ROAD BUILDING IN THE UNITED STATES AND SOUTH AFRICA

The NEPA (1969) in the United States reshaped Federally funded projects in this country. The ramifications of this act were felt around the world in various forms and at different times. In South Africa the 1982 Environment Conservation Act was that country's equivalent of the NEPA. Both the NEPA and the ECA were defining moments for these two countries as far as environmental matters were concerned.

While it is generally accepted that aesthetics is a discipline related to philosophy and the arts and thus is essentially different from engineering, a science, it would be wrong to conclude that in general the engineer, while knowing where the concrete ends, does not understand the soft world.¹⁵ Engineers have generally been trained to design with function, utility and cost as their primary objectives, while the look and/or artistic appeal has been a secondary consideration. Only recently (postcolonial and post-NEPA) have engineering works been supplemented with input from landscape artists and architects. It may be true that the educational background of the South African engineer reveals a lack of studies in aesthetics (and environmental considerations) and that the modern engineer has generally been trained as a narrow tech-

¹⁴ C. M. Spence, "Summary report - engineering our environment: destructive or constructive?", *The Civil Engineer in South Africa*, 26, 8, (1984), p. 391.

¹⁵ Clarke. *Civil engineers*. p. 413.

nologist.¹⁶ Nonetheless, to categorize the profession and label the person, would be unwise unless it was obviously done tongue-in-cheek. It is within the engineering profession itself that calls for a balance between the arts and the sciences in the training of engineers has been made. It is quite possible then that the President of the South African Institute of Civil Engineers in 1986, Ken Witthaus, was subconsciously reacting to the categorization of his profession and to jibes by journalists like James Clarke¹⁷ and others, when he called for this balance. It is clear then that this was a sensitive issue.

Yet despite this 'flaw' in their training, a number of the greater South African engineers have in fact been people of many perspectives.¹⁸ Thomas Charles John Bain (1830—1893) was one. A competent artist, an amateur archaeologist and geologist, a botanist and a talented musician,¹⁹ his engineering work certainly had an aesthetic quality to it — or can be classified as being 'pseudo-environmentally friendly'.

His road building, and particularly mountain pass construction methods, while not undertaken for environmental impact reasons, were/are certainly environment 'friendly'. On the Zwartberg Pass and on Bain's other works in the Southern Cape, like the Passes Route between George and Knysna, the roadway has been built up and the dry stone pack retaining wall used.²⁰ The retaining walls blend in with the mountain side and whatever excess material may have slipped over the side has been minimal.

The building of dry stone pack masonry retaining walls was a craft

¹⁶ Spence, *Summary report*, p. 391. A study of U.S. engineers needs further research for a more meaningful comparison.

¹⁷ Clarke, *Civil engineers*, pp. 412—417; K. Witthaus, "Look back to the future", *The Civil Engineer in South Africa*, 28, 3, (1986), pp. 79-81.

¹⁸ Witthaus, *Look back*, pp. 35—38 lists Charles Michell (1793—1851), Charles Bell (1813—1882), Thomas Bain (1830—1893), Francis Kanthoek (1872—1961), Alfred Snape (1881—1946), Theodore Watermeyer (1879—1948) and Jeremiah Jennings (1912—1979) as some of South Africa's greater engineers. Space has not permitted a study of U.S. engineers — this is an aspect which needs further research.

¹⁹ Cape Archives Depot, CCP 11/4/1 Civil Service List 1885, p. 81; P. Storrar, *A Colossus of Roads* (1984), pp. 13—19; G. Lister, *Reminiscences of Georgina Lister*, (1960), pp. 2, 21; and T. Goetze, "Thomas Bain, Road Building and the Zwartberg Pass", M. A. thesis, Stellenbosch University, 1984, pp. 23—28.

²⁰ Goetze, *Thomas Bain*, pp. 120—123.

taught to convict overseers.²¹ They in turn supervised the convicts in the dressing and placing of the stones. Modern techniques and materials have, however, ensured that this method is now seldom used.²² One must obviously be careful not to wax too lyrical on the environmental friendly appearance of Thomas Bain's work and thus by implication hold him up as a civil engineer/ environmentalist *par excellence*. A study of the Tsitsikamma region of the Southern Cape in South Africa now reveals that there were/ and are long term ecological affects of road building in this region. On the works undertaken by Bain (over a century ago) in this region, clearings in the forest have allowed the moisture to escape and the sunlight to come in. This has breached the micro-climate of the region. Ecologists now fear that the temperate evergreen forests of this area have shrunk and that the long term survival of the region is at stake.²³ The reduction and threatened existence of the Knysna elephant is perhaps another example of the impact of human activity in this region.

The choice of routes and the construction of roads in South Africa generally, and the Southern Cape specifically, have certainly been shaped by various and different considerations over the past \pm 100 years.²⁴ These have ranged from topographical, terrain, vehicular factors, to regional, economical and political considerations. Environmental impact considerations have up until the last 20 to 25 years seldom been a factor at all. The choice of routes has been linked more to engineering techniques and cost factors than to aesthetics or environment sensitivity.²⁵

²¹ The use of convict labour on the building of early roads in the U.S. is another area needing further research and comparison.

²² However the manner in which the Tradouw Pass, originally opened in 1873 and constructed by Thomas Bain (between Barrydale and Heidelberg), was rebuilt in the second half of the 20th Century, also indicates that the modern engineer wanted to both recreate the Thomas Bain finish and minimize damage to the environment. Most of the material excavated was either re-used or taken away. The constructors of the Tradouw Pass in most cases opted for retaining most of the excess material and hiding it behind gabion walls. Interview with R. V. Riley, Technical Assistant (Civil), Oudtshoorn, 13-8-1991: A gabion is a net encasing loose stones measuring approximately 2m x 1m x 1m.

²³ D. Bristow, "The other Garden Route", *Car* (April, 1991), pp. 71—72.

²⁴ J. Burman, *The Little Karoo* (1981), p. 142; Goetze, *Thomas Bain*, p. 129. Here too further research is necessary for a comparative study.

²⁵ The Outeniqua Pass route (between George and Oudtshoorn) was for example, amongst other reasons, chosen to cater for the modern motor vehicle. Built to replace

The major difference between road and mountain pass building in the days of Thomas Bain, as compared to the days in which the Outeniqua Pass (see footnote 25) was built, was that in Bain's day road builders built up and went around spurs and along contour lines, whilst with the use of modern machinery it was easier to go through the spur and to cut away and discard excess material. In building the Outeniqua Pass the mountain side was cut into and excess material was mostly pushed over the side, compacted and used as a fill or bridge. It is true that the use of this construction method became more streamlined and better managed over the years as engineers sought a good balance on the cut-and-fill basis.²⁶ It was too expensive and labour intensive to cart material in, so the creed was almost "what you abuse you must try to use". Nonetheless, the scars on the environment through the use of modern machinery and through this cut-and-fill method, particularly on the Outeniqua Pass, are still glaringly apparent. The major consideration for the use of this method had certainly been economical. The environment has in most cases had to pick up the bill.

the Montagu Pass, in use since 1849, it was started in 1943 during World War II by using 800 Italian prisoners-of-war labourers. It was also part of the wider National Road network scheme being planned and built at that time. In building the Outeniqua Pass, cuttings were made into the mountain side up to 70 feet (21,3m) deep. Gorges also had to bridge falls of up to 100 hundred feet (30,5m) high. Projecting rock masses were blasted away and a summit box-cut was undertaken, removing 77 000 cubic yards (58 874 cubic) of material. This pass took eight years to complete. Black labour eventually replaced the Italian labourers and the pass was opened on 20 September 1951 by the Minister of Transport. It is clearly apparent that more sophisticated tools and equipment were available for this project. Bain only had picks, shovels, crowbars, and sledgehammers at his disposal on the Zwartberg Pass, whereas the more modern equipment included road plants, concrete mixers, bulldozers, graders, rollers, etc. The more sophisticated and technologically advanced people became, the less respect, it seemed, they held for nature; T. V. Bulpin, *Discovering Southern Africa* (1970), p. xvii; J. Burman, *So high the road* (1963), pp. 102—103.; Haley, *Harsh mistress*, pp. 149—163, 249—262. An interesting aside is the Italian connection in highway building both in South Africa and Colorado. Edgardo Contini was one of the "inspired" designers appointed to design the I-70 through Glenwood (see Haley, *Harsh mistress*, pp. 151—152); the Autostrada of Northern Italy was pointed out as being a good example of a road sculptured out of its environment (*Rocky Mountain News*, 11 April 1973); and Italian prisoners-of-war were used on road building projects in South Africa in the 1940s, and were arguably of the last breed of stonemason artists around.

²⁶ See also M. C. Wiley, *The High Road*, (1976), p. 26.

THE HISTORY OF ROAD BUILDING IN COLORADO

Roads also run through the recorded history of Colorado. Although this recorded history goes back some 400 years one must obviously not discount the role of pre-historic people who also tramped trails in the region. The terrain and topography of this, the highest state in the United States, obviously militated against these earlier people and their attempts to colonize the region and make it more habitable and a servant of their needs.

Trails were initially left by animals and hunters alike. The Indians of the region generally followed the trails of these animals, mainly deer and buffalo. One generation after the other followed the tracks of their predecessors. The result was that the ground became compacted and the vegetation somewhat affected. Most trails through the mountains followed contours and/or generally the paths of least resistance. Indian trails along the plains cut into the earth as they moved in groups with horses, teepee poles in tow, this on annual caravan trading expeditions to New Mexico. The first whites to visit the region would burn trees on the routes these Indians used, so that they would be able to find their way home. The return trips often took place after seasonal changes would have changed their markers.²⁷

In the early part of the 19th Century it was the 'mountain men', adventurers who went into the Rockies to hunt, trap, trade, fight and/or 'go native', who were the main users of trails and early roads. Before gold was discovered, the main routes on the plains of Colorado for freighters and stage lines were the Smokey Hill (from Leavenworth, Kansas, to Denver) and the Overland Trails (along the South Platte from Atchison to Denver).²⁸ As gold camps developed after 1849, many more routes were 'built'. Population flows in and out of the region increased²⁹ and the impact on the environment obviously became more profound. Silver succeeded

²⁷ Early routes used by Indians to be followed by early white explorers (initially Spanish) include the Sangre de Cristo Pass, the trail across the San Luis Valley to Pagosa, Raton Pass, Whiskey Creek Pass, Francisco Pass and the Cherokee Trail. See Wallis Reef, *Development of Colorado's Highway System*, chapters 1, 2, and 4.

²⁸ *Ibid.*, chapter 1.

²⁹ Wiley, *High Road*, p. 13, gives the following figures: 1860 — ±34 300; 1870 — ±40 000; 1880 — ±194 000; 1890 — ±413 000; 1900 — ±540 000; and 1910 — ±800 000.

gold as the mineral of extraction in the 1880s and 'nature' was arguably the major victim.

It was also in this period of the second Industrial Revolution that technology became more advanced. One result was that the alienating awe that people held for nature lessened. As it became easier to 'conquer' nature,³⁰ so people's respect decreased. As in postcolonial settings 'familiarity' with nature affected people /nature relations.

Towards the end of the 19th Century³¹ the State Senator from Glenwood Springs, Edward Taylor, called for the further opening of his region to outsiders.³² A road through Glenwood Canyon would not only complement the Colorado Midland Railroad, but would also increase access to the town's mineral springs. The result was a rough and ready one-lane wagon track on the north face of the canyon (named Taylor's Road), this opposite the railroad on the south side.³³ The dam that was built in 1909, as well as the Shoshone Power Plant, also affected the face, heart and character of the canyon. The dam, positioned in the *heart* of the Canyon stopped the free-flowing Colorado River. It was as if the two routes, the railroad and road, were surgical by-passes to a blockage that inhibited free flow through the canyon.

The wagon route became obsolete as motor vehicles came into the equation. By the 1930s the road that had replaced the wagon

³⁰ When the commissioner of Crown Lands of the Cape Colony (in South Africa) opened the Zwartberg Pass in the Southern Cape in 1888, one of his main comments was that "nature had been conquered" (as quoted in Goetze, *Thomas Bain*, p. 143). Although no comparative statement has been found, it can be assumed that this was generally the attitude of earlier officials, and rail and road builders, after successfully undertaking very difficult construction works where 'nature' was seen as a formidable opponent. It would be interesting to study the life and work of a 19th Century Colorado toll road builder like Otto Mears (see Wiley, pp. 6—7 and Otto Mears — path finder of the San Juan, in Pam Files, University of Colorado archives) in comparison to that of a road builder in South Africa (Cape Colony) during the same period (some aspects of Thomas Bain's work are dealt in this essay). This is however an aspect which needs further research.

³¹ For the purposes of this paper the history of the canyon is taken from the last two decades of the 19th Century, the period from which people entered the canyon and reshaped it.

³² *The Denver Times*, 3 Dec 1898.

³³ Enoch Needham, "Take this road and pave it", *The Denver Post Magazine*, 24 Oct 1982, p. 26.

track was also obsolete. The U.S. Army Corps of Engineers developed a two-lane route in the canyon from 1936—1938³⁴. After World War II new interest in road building surfaced, with particular interest being shown in a national highway system. Although studies for such a system were approved in 1944, and again in 1947, it was only in 1956 under the Presidency of Dwight Eisenhower that a National System of Interstate and Defence Highways was approved and put into operation.³⁵

In the original plan, Colorado's routes included the Wyoming line south of Cheyenne to the New Mexico line near Raton Pass (now the I-25), the Denver to Nebraska line (I-76) and the Denver to Kansas line (I-70). There was no initial westward expansion from Denver authorized. Politicians from Colorado, and to a much lesser extent Utah, actively sought this link. Opposition from Utah, especially from sections within Salt Lake City, in fact feared that a road as far south as was being planned would hurt the city.³⁶ The delay that was caused by the Utah opponents of the route ultimately affected the construction of the I-70 through Glenwood Canyon. The delay resulted in the passing of the NEPA (1969) coming between any substantial development on the I-70 through Glenwood Canyon, and a subsequent radical rethink on the route, design and construction of this highway.³⁷ This delay brought engineers into direct contact (and conflict) with environmentalists.

Numerous articles in the *Denver Post* written on the Glenwood Canyon Highway saga over the period 1970—1984 highlight the controversy that this project subsequently evinced.³⁸ At least 60 different Federal, State and local agencies became involved in the issue, ranging from the Council on Environmental Quality, the Bu-

³⁴ Ibid.

³⁵ Wiley, *High Road*, pp. 30—31; and Haley, *Harsh mistress*, p. 95—99.

³⁶ Needham, *Take this road*, p. 26.

³⁷ Ibid.

³⁸ "Order for study of I-70 route praised", *Rocky Mountain News*, 11 April 1973; Editorial, "Build this road right", *The Denver Post*, 22 March 1978; Editorial, "Worth waiting for", *The Denver Post*, 21 Sept 1979; Kit Miniclier, "Canyon project erases dreams", *The Denver Post*, 27 Sept 1981; Kit Miniclier, "Glenwood Canyon Road faces cutback", *The Denver Post*, 27 Sept 1981; Joseph Garcia, "Expert defends roadwork plans near Glenwood", *The Denver Post*, 13 June 1984; and "Environmentalists lose in bid to halt canyon work", *The Denver Post*, 14 June 1984.

reau of Land Management, the U.S. Forest Service, the State Highway Department, the Division of Wildlife, the Bureau of Outdoor Recreation, the Rocky Mountain Centre on Environment (ROMCOE), through to Club 20 (representing 20 Western slope countries), the Colorado Open Space Council and the Citizens for a Glenwood Canyon Scenic Corridor.³⁹ At issue were many considerations: the route, the two or four-lane debate, traffic and road-carrying capacity issues, minimum safety and speed requirements, as well as visual, noise, vegetation (and revegetation), wildlife, recreation facilities, and other factors.

Three routes were explored: Cottonwood Pass, the Flat Tops route and the Canyon route itself.⁴⁰ The Flat Tops alternative was rejected because it added 42 miles on to the canyon route, was estimated to cost five times as much, and it ran over very rugged terrain. The Cottonwood Pass alternative required some steep gradients at high altitudes and added over nine miles to the canyon route. Many argued against the traditional cut-and-fill techniques that were initially planned, fearing that permanent and irreparable disfiguration to the Canyon's face and heart would occur. Ultimately the Canyon route was chosen, but only after many hours of deliberation, conflict, and design alteration had gone into the issue. However, despite the ultimate compromise reached, not all were thrilled with the outcome.

The conflict over whether a two or four-lane highway should be built was a long and an emotive issue. It was only settled after District Judge John Kane ruled that the concerns of the environmentalists, that the scenic beauty of the canyon would be harmed, were outweighed by traffic safety considerations and the cost of further delay.⁴¹ One of the biggest factors driving those who pushed for the four-lane highway was the safety aspect. The road through Glenwood Canyon had been called the most unsafe stretch of highway in the whole highway system.⁴² Twenty-one

³⁹ Wiley, *High Road*, pp. 30—31; and Haley, *Harsh mistress*, pp. 95—99.

⁴⁰ Haley, *Harsh mistress*, p. 117.

⁴¹ "Environmentalists lose in bid to halt canyon road work", *The Denver Post*, 14 June 1984; and Haley, *Harsh mistress*, pp. 117—118.

⁴² By Jack Kinstlinger who was the director of the Colorado Highway Department in 1978, as quoted by E. Needham, "Take this Road and pave it", *The Denver Post Magazine*, 24

people had died on this route between 1970 and 1980, far above the average for any equivalent stretch of road. The prediction of the estimated flow of traffic through the canyon by the year 2000⁴³ also carried a lot of weight with Judge Kane, as did the cost factor.⁴⁴

While it is profoundly ironic that opponents of the road (mainly environmentalists) were now citing the cost of the route as a reason to oppose its completion and engineers were pointing to the protection of the environment,⁴⁵ it seems clear that on the part of the environmentalists this was merely a change in tactics. When the irony of their new stance was pointed out, the answer was that it was a "different strategy to achieve the same goals".⁴⁶

In a clear example of the blending of aesthetics with functional and utilitarian aspects the so-called 'inspired designers'⁴⁷ who were hired to design the Glenwood project were innovative. It appeared that the (civil) engineering fraternity were becoming freshly aware of their own creative capabilities and the need to work more in harmony with nature in their designing. The design and construction measures used in the building of the Glenwood Canyon Highway were certainly innovative.⁴⁸ They took into consideration and

Oct 1982.

⁴³ This daily prediction of 12 050 vehicles was not without criticism. See "Expert defends roadwork plans near Glenwood", *The Denver Post*, 13 June 1984; and "Roadwork is disputed in Glenwood Canyon", *The Denver Post*, 8 June 1984.

⁴⁴ In 1980 a Reagan administration advisory group suggested that the remaining 1 547 of the 42 500 total miles of Interstate Highways planned, should not be completed as it was estimated that it would cost just as much to complete those remaining miles as it had cost to complete the other $\pm 96\%$ ($\pm \$80$ billion had already been expended on the highway system). The reason for this high estimate to complete the remaining 4% of the system was that $\pm 1/3$ of the remaining highways to be built were controversial and tied up in environmental lawsuits. It was thus estimated that it would cost $\pm \$500$ million to complete the Glenwood Canyon route. Any delay would push the cost up. In addition 1986 was set as the close of date for any bid-letting on federal highway projects: "Reagan Panel asks for cutoff on Interstate road work", *The Denver Post*, 27 Dec 1980.

⁴⁵ Robert Tweedell, "It's time for a hard new look at cost of Glenwood Canyon", *The Denver Post*, 8 June 1980; John Toohy, "Roadwork is disputed in Glenwood", *The Denver Post*, 8 June 1984; and Needham, "Take this road".

⁴⁶ Roger Hansen of ROMCOE as quoted by Needham, "Take this road".

⁴⁷ Haley, *Harsh mistress*, pp. 149—163, 249—262.

⁴⁸ Some of these innovative measures included: the terraced highway, tie-back retaining walls, post-tensioned concrete slabs and the use of a self propelled gantry. See Haley, *Harsh mistress*, pp. 249—262.

brought together interstate highway and budget requirements with scenic, recreational, and environmental considerations.

Although some vegetation [32 acres (12,8 hectares)] was inevitably removed from the canyon floor with the construction that took place, another 80 acres (32 hectares) were put back with the planting and vegetation that took place in the rest areas.⁴⁹ Part of the budget for the highway included \$1,5 million for a nursery to provide shrubs and plants for landscaping measures.⁵⁰

Despite the fact that it was not possible to please all of the people all of the time, the Glenwood Canyon four-lane highway project can be considered successful. It was lauded as a "prototype" for future architects and engineers⁵¹ by Sam Caudill, chairman of the Citizens' Advisory Committee to the Glenwood project. Were people and nature possibly renewing an estranged relationship?

In an ironic twist to this apparent reconciliation, an experimental retaining wall was built of shredded and compressed auto tires near the Hanging Lake Section of the I-70 in Glenwood Canyon fairly recently.⁵² The project aimed to give a bit of cosmetic attention to an ugly scar on a hillside caused by previous construction. A fire however destroyed much of this.

THE HISTORY OF ROAD BUILDING IN THE GARDEN ROUTE

A comparative study of road and bridge-building activity in the Southern Cape in South Africa in the second half of the 20th Century is interesting for a number of reasons, the most important probably being for environmental considerations. It reveals that while South Africa was generally ten to fifteen years behind the USA as far as environmental legislation was concerned, they certainly were conscious of environmental considerations as far as road building is concerned in the 1960's period.⁵³ This is the period during which environmental considerations came into the planning and building of the I-70 through Glenwood Canyon. The period

⁴⁹ Needham, *Take this road*.

⁵⁰ *The Denver Post*, 21 Sept 1979.

⁵¹ Haley, *Harsh mistress*, p. 269.

⁵² Michael Book, "Glenwood's wall of recycled tires a burning issue", *The Denver Post*, 1 Nov 1995.

⁵³ B. C. Floor, *The history of National Roads in South Africa*, (1985), p. 76.

between 1967, when the National Transport Commission appointed a landscape officer to look into ecological aspects of road building on the Garden Route, and the 1982 promulgation of the Environment Conservation Act, certainly provided a learning experience second to none. The EPPIC was established within this period (1974), in order to advise engineers, architects and planners on how to handle and manage conflict between development and conservation. Like NEPA, EPPIC produced significant philosophical and procedural guidelines on how to protect the environment.⁵⁴ By 1980, in both our study cases, there was also seemingly consensus among those in the planning professions about the necessity of public participation in the initiatory stages of project planning. There however was still division on how much participation and how this participation could best be achieved.⁵⁵ There was also apparent agreement that environmental consideration should form an essential part of the planning process, that disclosure was necessary, and in addition, more of an acceptance of the fact that environmental considerations could necessitate "modification, adaption or even the abandonment of a project".⁵⁶

The first investigations for a road/route to replace the long and winding hairpin bend passes of the Groot and Bloukrans Rivers were done in 1942 using an unusual measure, namely a Dakota aeroplane.⁵⁷ From the early 1950s, engineers of the Department of Transport and the Cape Provincial Administration, continued with these preliminary investigations.⁵⁸ In 1963, more investigations were done so that by 1965, surveys could begin in earnest. Much debate and difference of opinion followed. A coastal route was proposed by the National Road Board. The Provincial Administration wanted an inland route which would have been 7 km (4.42 miles) longer (in total 45 km or 27.9 miles long) than the proposed

⁵⁴ Spence, "Summary report", p. 391.

⁵⁵ E. J. Hall et al, "Environmental protection", *The Civil Engineer in South Africa*, 22, 5, (1980), p. 129.

⁵⁶ G. E. Blight, "Shaping our Environment", *The Civil Engineer in South Africa*, 22, 5 (1980), p. 135.

⁵⁷ "Tsitsikamma Nasionale Pad en Brûe wen SAISI-toekenning", *The Civil Engineer in South Africa*, 27, 10 (1985), p. 528.

⁵⁸ J. J. Smit, "Die Nasionale Vervoerkommissie se stempel op die Tsitsikamma", *The Civil Engineer in South Africa*, 26, 4 (1984), p. 7.

coastal route.⁵⁹

An alternative route was sought by the National Transport Commission and thus in 1970 consultant engineers were brought in. Between 1971 and 1977 three different sites for the Bloukrans Bridge were surveyed and investigated and design work on the bridges started. Aesthetic and ecological considerations also played an important role in the final choice of bridge design, choice of routes and sites,⁶⁰ and in construction restraints imposed.⁶¹

The route in the vicinity of the Bloukrans Bridge was relocated in order to reduce damage to the indigenous forest with the exact location for the bridge being determined by judgement on the basis of risk in terms of the relative soundness of rock formations.⁶² Other considerations related to the cost in terms of the cut-and-fill of the road approaches. This bridge was thus finally located +2 kms down from the original site and +2 km (1.2 miles) from the sea where the gorge is +216 m (418.2 yds) deep, at a point where the gorge had a longer span than the alternative sites investigated.⁶³ Factors that helped shape and determine the design of the bridge included practicality, reliability, durability, total cost, aesthetic quality and environmental impact.⁶⁴

The Groot River Bridge, situated 10 km (6.2 miles) west of the Bloukrans, was designed according to much the same considerations. Here the specifications were important for they required that no excavation spoil fall into the gorge. An exception was made on the west bank because of its initial inaccessibility. All excavated material falling into the gorge here had to be cleared at a later stage.⁶⁵

⁵⁹ Ibid.

⁶⁰ Floor, *National Roads*, pp. 75—77.

⁶¹ Ibid., pp. 76—77; "Tsitsikamma nasionale pad en brúe wen SAICI-toekenning", *The Civil Engineer in South Africa*, 27, 10 (1985), p. 528.

⁶² A. C. Liebenberg et al, "Developments in bridge design, with special reference to concrete arch-type bridges in South Africa", *The Civil Engineer in South Africa*, 26, 4 (1984), p. 147; A. C. Liebenberg, "The planning design and analysis of the Bloukrans Bridge", *The Civil Engineer in South Africa*, 26, 4 (1984) pp. 159—160.

⁶³ Liebenberg, *Bloukrans bridge*.

⁶⁴ Liebenberg et al, *Bridge design*.

⁶⁵ The contractor was in fact saved this trouble as the stream below carried the debris

Because of the destruction of great quantities of 'fynbos' and other indigenous plants, and due to the ecological sensitive nature of the area, it was necessary to undertake large scale rehabilitation and other landscape forming measures.⁶⁶ Forest vegetation was cleared and 'fynbos' chips were thrown over the area during the construction of the new N2 highway. The aim was to establish indigenous vegetation in all of the cleared areas. In other areas, branches that were chopped down were covered with leaves and seed and placed on the ground. Another technique was to use re-vegetation capsules (known as 'sausages') and place them on the hills and slopes. Topsoil from the region was used to fill the capsules and the ground was then hydro-seeded with indigenous buffalo grass. Within three years of construction much of the indigenous vegetation had been re-established.⁶⁷

Another project quite unique in terms of re-vegetation was to take plants from the edge of the forest and replant them on the side slopes of the new road. An approximate 80% success rate was achieved here. The cost of this rehabilitation and other landscape forming measures came to more than R1 million (or \pm \$270 000 in today's terms).⁶⁸

The N2 route between Cape Town and Port Elizabeth was upgraded in sections. Another section to be upgraded (involving reconstruction and widening) was the George to Kleinkrans section running past the Wilderness (the irony of the name of this village with a major highway running alongside it is not lost) and Kaaimans areas (\pm 16 kms or 10 miles). As this area, like that of Glenwood Canyon, is a major tourist attraction and thoroughfare, great care had to be given to aesthetic, ecological and nature conservation aspects. The road traverses sand dunes, runs parallel to the

away — subsequent tests that were carried out revealed that the river water was unaffected by filtering through the debris. The vegetation on the bank below the west springing was completely stripped by the falling material. This was, however, completely reinstated before the end of the contract. In addition the foundations were backfilled to ground level to reduce scarring. D. E. Reffel, H. C. Parolis and P. R. Labrum, "The Groot River Bridge", *The Civil Engineer in South Africa*, 26, 4 (1984), pp. 175—178.

⁶⁶ "Tsitsikamma nasionale pad en brûe wen SAICI-toekenning", p. 528.

⁶⁷ "Hervestiging van plantegroei by padbouprojekte kry toenemende aandag", *The Civil Engineer in South Africa*, 26, 9 (1984), p. 421.

⁶⁸ Ibid.

sea and runs through a natural forest with a large variety of indigenous trees, plants, and shrubs. Prior to starting the detailed design on the project Professor E. Moll of the University of Cape Town inspected the route to assess the quality of the vegetation adjacent to the road. He found that generally speaking, the trees and shrubs covering the old cuts and fills were not of a good quality and that proper planning of the re-vegetation of the new planned cuts would in fact improve the situation. To achieve this, strict conditions and constraints would have to be laid down in the contract documents. The crossing of the Swart, Kaaimans and Touw Rivers were discussed with Dr A. E. Heydorn of the National Research Institute of Oceanology (NRIO) before the structures were designed. The considered opinion was that as none of these rivers had mud flats, therefore the temporary filling of the streambed would not have had too dramatic an effect on the rivers and nor would the bottom fauna have been seriously affected. Thus the decision to widen the road by means of conventional earth banks in the area of the crossing of the Kaaimans was taken. The site was given over to the contractor in March 1984. By October 1984 the Kaaimans Action Group were up in arms when it became clear that some of the fills would encroach on the Kaaimans. They called for an independent environmental impact assessment (EIA) on this river estuary. The Action Group, the client, the local Member of Parliament, as well as the Minister of Transport and the Minister of Environment, became involved in discussions on the issue. The work was halted and a fresh EIA sought. Professor Van Wyk of the National Transport Commission for Ecological Research attached to Potchefstroom University, Mr Willem van Riet, a landscape artist, and Dr A Heydorn of the NRIO were called in.⁶⁹

Dr Heydorn confirmed the original design finding that no significant effect would be suffered by the estuary.⁷⁰ Work on the Kaaimans

⁶⁹ J. Verdwyn and T. G. Wiese, "The construction of the National Route N2-7 between George and Kleinkrans, a section of the Garden Route", *The Civil Engineer in South Africa*, 29, 12 (1987), pp. 467—473; "The reconstruction and widening of the N2/7 between Kraaibosch and Wilderness", *The Civil Engineer in South Africa*, 31, 1 (1989), pp. 5—9.

⁷⁰ The reason, in his opinion, was that the bottom fauna of the estuary was relatively poor and that it would re-establish itself once the system reached a new equilibrium. The earlier findings of Prof. Moll were confirmed. These were that the vegetation on the

fill resumed in November 1984. After the reaction a full-scale public relations exercise had to be put into operation to ensure further understanding and co-operation.⁷¹

The Swart River to the Kaaimans portion consisted of a large quartzite cut. A section here was rounded and terraced to blend in with adjacent natural slopes and the remainder of the hard rock portion excavated using pre-split blasting techniques along with the use of varying drilling planes. The result was that small holes ('pockets') were created to retain the topsoil for the planting of wild geraniums, canary creepers and indigenous shrubs. The cut face was then also hydroseeded and sprayed with surfasol. In addition, vegetation 'sausages' were tied with barbed wire to the cut face. Holes were created in the slope faces and planted with shrubs while the face was then also hydroseeded. The Swart River Gorge and the Kaaimans Waterfall were cleared of rocks deposited from the construction of the road in 1948. 'Fynbos' chips and seeds were harvested in the Rondevlei area and used to stabilize and re-vegetate the cut and fill slopes.⁷²

These two projects were eventually completed amid much controversy, public scepticism, continuous media scrutiny and difficult traffic accommodation and ecological restrictions. These works, probably more than any other at that time, in South Africa and in the United States, underscored the necessity for the collaboration and deliberation of various disciplines and professionals (ecologists, engineers, landscape artists) at the design stage.⁷³ These were both certainly hands-on learning experiences.

CONCLUSION

A study of the control measures that were undertaken in both of the above-mentioned projects, in Glenwood Canyon and along the

Kaaimans and Swart River slopes was not a climax vegetation but a secondary vegetation with a low diversity of species due to previous road construction disturbances. He did, however, find that the re-vegetation measures in the contract document did not adequately account for the different ecological zones in the area. The National Transport Commission's Institute for Ecological Research (attached to Potchefstroom University) was appointed to advise on re-vegetation matters.

⁷¹ Ibid.

⁷² Ibid.

⁷³ Ibid.

Garden Route, reveals that those involved in the planning of civil engineering projects, especially in as far as road building was concerned, had to take serious cognisance of environment impact considerations. It becomes apparent that the engineer in both cases was required to formulate unique and innovative measures and adapt conventional construction techniques to deal with varying and individual situations. Civil engineers now also realized that for the successful completion of projects it was essential to engage in prior consultation with many different people and bodies/organizations. It was essential that the viewpoints of the tax-payers, the road planners, the designers, the builders, the road users, the landowners requiring access to their properties, the road administrators, the traffic police, and not least environmentalists, needed not only to be considered, but that consensus had to be reached as well.⁷⁴

The factors contributing to the total environmental impact of secondary and major highways are numerous. Amongst those that have not been considered in this paper are the following: the noise factor, exhaust emissions (gaseous) and other pollutants associated with vehicle movement like dust, salt, spray, polluted run-off and air turbulence. The lead content of petrol, currently under review in South Africa, in the form of tetraethyl and tetramethyl, is emitted from vehicles in the form of fine particles. On tests done in the United Kingdom it was discovered that large contamination of the roadside occurs, some of this spreading even beyond 100 m (130.8 yds) of the roadway.⁷⁵ Scant attention has been given to these matters in South Africa and it becomes obvious that any comprehensive EIA is complex and difficult to quantify.

Other factors that have not received much consideration in South Africa include the manner in which the speed that vehicles travel and the noise level affects remote and sensitive wildlife populations. As traffic levels increase along with vehicle speed and road widths, the danger of roads becoming greater causes of habitat isolation is likely to increase. The road acts as a series of barriers

⁷⁴ Floor, *National Roads*, p. 92.

⁷⁵ D. M. Colwill and J. R. Thompson, "Assessing the impacts on plants of major highway development" in R. D. Roberts and T. M. Roberts (eds.), *Planning and Ecology* (1984), pp. 269—272.

to the movement and migration of smaller cover-loving animals. In addition roads interrupt micro-climatic conditions and become arteries of emissions and disturbances, zones of instability due to cutting and spraying and provide little cover for smaller animals against predators. Many of these smaller animals are also at risk due to moving wheels.⁷⁶

In forest areas road construction has soil erosive effects. Studies in the United States have shown that the equivalent of many decades of natural and even agricultural erosion may take place during a single year in areas cleared for construction.⁷⁷ However once the construction phase has ended and disturbances are minimized, roads surfaced and lawns cultivated, the rate of erosion then falls markedly.

Roads have also been an important factor in the spreading of plants. By opening up an area and producing a route for their kind, people have also become facilitators for the entry of plants into an area. Roads also provide a specialized habitat for plants to establish themselves alongside the road margins. They thus supply "a cohesive directional component cutting across physical barriers, linking suitable habitat to suitable habitat".⁷⁸ In short indigenous plants are at risk of being colonized.⁷⁹

Historians clearly need (in South Africa particularly, for it appears that in the United States the field of environmental history has well established roots) to add their voices to the debate integrating a study of the history of the environment with the study of people's past, for in the view of the deep ecologist they are equals in a biotic community. They must become the voice recording the history and exploitation of the voiceless.

Environmentalists need to retain, and possibly even intensify, their efforts to keep the attention of those involved in infra-structural development clearly focused on the effects this development can and does have on a finite world. Nonetheless, environmental reformers

⁷⁶ A. Goudie, *The human impact on the natural environment*, (1990), p. 89.

⁷⁷ *Ibid.*, p. 148.

⁷⁸ *Ibid.*, p. 63.

⁷⁹ *Ibid.*, p. 64.

will also need to understand the links between their special concerns and those which concern the majority of voters. Majorities will need to be persuaded that the crisis of the environment is not a single issue; it's a social crisis, it's the economic crisis of industry, it's a postcolonial crisis, all of these being manifestations of an all inclusive environmental crisis.⁸⁰

And finally to our road running through this all. State highways⁸¹ (or national roads in the South African context) are the arteries of a nation. They have become the carriers of our modern civilization, carrying people and commodities and allowing for more meaningful communication. They link one part of the whole to another. They hold 'places' together, east-west, north-south, they integrate, and make more compelling the argument of William Cronon (in *Nature's Metropolis*) that urban and rural are one. There is no 'other', no outside. The inside has become the outside. The study of the roads through Glenwood Canyon and along the Garden Route show us that engineers and environmentalists traditionally represented as 'rip-and-tear' vs. 'bleeding heart', no longer represent two opposing groups. They represent people in totality torn apart through technological advance, seeking to find one another. They represent people in dialogue with themselves. They are not even two faces of humanity — they represent the same face. As the mountains and the land have been scarred (through road building) people have been scarred themselves.

The later part of the 20th Century will be seen as a defining moment when the mirror of people was held up to themselves. The mirror reflected the scars. People now go forward gently. They have recognized the destructive potential in themselves; they have recognized themselves; now seek to channel their new found creative energy.

⁸⁰ Young, *Post environmentalism*, p. 139.

⁸¹ Along with railroads and air-links.