Employment and High-Standard Infrastructure

Edited by:
RT McCutcheon and FLM Taylor Parkins

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In loving memory of:

Elizabeth Gregor

Ian Stewart Haggie

Jessie McCutcheon

Hannie Taylor Parkins-Rings

Rest in Peace 2002

All of whom supported these endeavours to generate employment.

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PREFACE

The **WORK** Research Centre for Employment Creation in Construction is located within the School of Civil and Environmental Engineering at the University of the Witwatersrand, Johannesburg, South Africa. **WORK**'s main objective has been to explore ways and means of generating employment and skills in the provision of infrastructure. For over 10 years research and field implementation in relation to the use of employment-intensive methods for the construction and maintenance of high-standard physical infrastructure have been carried out by, or in association with, the Centre. Particular emphasis has been placed on high-standard roads.

Some of Centre's research has been presented at conferences and published in journals; some has been documented in reports and dissertations. In 1999 the Centre considered that the body of work was now substantial enough to be of interest to those engaged in the search for ways to generate employment opportunities generally, and, in particular, in the construction and maintenance of major infrastructure. And, that the method of publication through journals did not necessarily reach the target audience. It also considered that the material deserved to be published in a consistent manner.

The Centre therefore embarked upon the publication of a series of working papers which have been produced over the last nine years at, or in conjunction with, the **WORK** Research Centre. Each paper has described and discussed an aspect of the research programme and related work, and it contains state-of-the-art insights and research findings of a range of methodologies, policies and techniques that surround the fields of employment creation, development engineering, and urban and rural infrastructure developments, mainly in South Africa. The intention was that each working paper should provide sufficient detail to be of theoretical and practical use to those who wish to investigate, replicate, or extend the implementation of employment-intensive construction.

It has now been decided that, together with additional material, a series of these working papers should be edited into a book for circulation to those engaged on similar work, for information, and at the same time calling for commentary.

We sincerely hope that you will find this a useful publication, with its array of outcomes, references and resources, and its broad and unique perspectives on the worlds of employment and development.

Robert T McCutcheon
Filip LM Taylor Parkins

Johannesburg, October 2003

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Filip LM Taylor Parkins

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1 WORK & PUBLIC WORKS: EMPLOYMENT & HIGH STANDARD INFRASTRUCTURE

R McCutcheon

"People not machines should be used to build the New South Africa"
Nelson Mandela, 1993[1]

Just to live we need air, water and food. To date air is free. Whether free or not, water has to be collected. For food you must either grow your own or buy, barter, borrow, beg or steal. Agriculture and animal husbandry continue to form a cornerstone of development; and improvement in people's ability to produce their own food is germane to any broader discussion of employment generation.

If you cannot produce your own food, buying (a form of barter) is not only ethically preferable but should lessen the need for the other options for survival. In order to collect water and produce food or earn the money to buy them, we have to work. Work – or access to the resources of those who work – is required first for subsistence, and then for the other things that make life worth living. Work is central to existence. Work is the means whereby we recreate ourselves and the world around us.

But by itself, work cannot guarantee subsistence. Without it however, survival is tenuous at best and poverty all encompassing. And there is a shortage of opportunities for work. The scale of the problem is immense. Poverty is a scourge. Of the world's 6 billion people, nearly half live on less than US$2 per day and over 1 billion on less than US$1 per day. They do not have enough food and/or money. Over 1 billion potential workers - one third of the economically active population - are unemployed or under employed in terms of seeking more money or earning less than is needed to keep their families out of poverty[2]. The debate continues as to the sources of poverty and how to counter it. The latter is dominated by economic growth. Proponents argue in its favour; while over the past 10 years "jobless growth" has been a feature of the South African economy. Faced with such a reality there are many proposals for poverty alleviation through so-called employment generation schemes which are simply minor expenditures with a marginal effect. There is a need to generate real jobs in the major economy. This book focuses upon one of the means to improve the lot of the poor who are willing to work within the major economy: the potential to generate a significant increase in employment opportunities per unit of expenditure through the use of employment-intensive methods in one sector of the economy: the construction and maintenance of major infrastructure. It challenges those engaged in the provision of infrastructure to grasp the opportunity to construct high-standard infrastructure and achieve a critical socio-economic objective, namely, employment. It also challenges other sectors to follow suit. Major problems cannot be solved by minor peripheral expenditures.

[1] Reported in: Brendon Templeton, "Call to use labour, not machines", Saturday Star, 4 December 1993, p2, South Africa.
[2] World Bank, *World Development Report 2000/2001: Attacking Poverty*, New York, OUP, 2001

Many sources of poverty have been identified, varying from exploitation of one kind or another to individual laziness. One source that has not received as much attention as it should, is the nature of industrialisation which has led to decreasing opportunities in the formal sector of the major economy for those who have little or no education and skills. The decline has been accompanied by an ideology which only sees employment being generated through further industrialisation accompanied by economic growth. These developments have also taken place in the civil construction industry which has traditionally provided the poor with an entry point into the major moneyed economy. The level of skills now required to function in the formal construction industry excludes the poor. The complexity of human nature and society mean that the sources of poverty cannot be completely eradicated. However, reason and reflection, accompanied by coherent action, have a role to play in a significant improvement of the human condition. The latter cannot be expected to occur if restricted to marginal economic activity such as various types of poverty relief. The major economy must provide opportunities for the poor to find their way out of the poverty trap. A corollary: surely the long-term health of the major economy, and society as a whole, is dependent upon such an incorporation of the poor? The poor need to become a part of production and consumption and not a part of those who have no work and become ill, or indigent, or turn to crime for survival; all of which may be viewed as economic costs that society as a whole has to bear. Thus, other avenues need to be pursued in addition to economic growth. One such avenue would be employment-intensive construction.

While more detail will be provided in Chapter 2, employment-intensive construction may be essentially defined as the economically efficient employment of as great a proportion of labour as is technically feasible throughout the construction process - including the production of materials - to produce as high a standard of product as demanded by the specification; the result being a *significant* increase in employment opportunities per unit of expenditure.

Since the early 1970s, the use of employment-intensive methods has been explored as a means for both the construction and maintenance of public works and efficacious generation of significant additional employment opportunities per unit of expenditure. In theory and small-scale experimentation these methods were found to be effective in many aspects of civil construction. However, to date, in Africa, employment-intensive methods have only been used on a large-scale, over a long period of time, for the construction and maintenance of low-cost, low-volume rural roads. In relation to such roads it would be fair to say that most of the technical issues have been resolved; the best method for large-scale implementation remains moot.

Despite the original research which indicated applicability across a wide range of civil construction, large-scale implementation has not taken place in relation to the provision of physical infrastructure in the major economy. Some of the reasons for this lack of development relate to the nature of the sub-sector itself, others to the nature of the profession and the industry. In particular, there has been significant resistance on the part of engineers to the consideration of the use of employment-intensive methods in high-standard, high-cost construction required for heavily-trafficked roads and comparable work in other sub sectors. The irony is that - as will be seen - engineers have an essential role to play in the development of employment-

intensive methods because of the attention required for technical details and the managerial competence needed for the sound implementation of such projects.

Rural road implementation has been important in its own right: it has generated employment amongst a population group that is generally poorer than the rest and provided access in areas that are generally less well served than others. However, a tiny proportion of money is spent on low-cost, low-volume rural roads by comparison with the expenditure on high-cost, heavily-trafficked roads. And, expenditure on roads absorbs a large proportion of that on civil construction as a whole. Investigation of the potential for using employment-intensive methods for heavily-trafficked roads could lead to a significant increase in employment per unit of expenditure in the sub-sector, which forms an important component of both the infrastructure and the major economy. Similarly, this potential could be pursued across the spectrum of high-standard civil works.

For over 10 years research and field implementation into the use of employment-intensive methods relation to high-cost, high-standard infrastructure has been carried out by, or in association with, the WORK Research Centre at the University of the Witwatersrand in South Africa. The work has not only reaffirmed the conclusions of the earlier research, it has enlarged the scope of application of the concepts. It has demonstrated that employment-intensive methods may also be used for high-standard, heavily-trafficked roads and other high-standard infrastructure without compromising economic efficiency. Furthermore, for many more operations than anticipated, it has demonstrated that construction using employment-intensive methods can be ***cost competitive*** with conventional capital-intensive work, without compromising time and quality. Since the bulk of major civil construction is by the public sector and on high-standard infrastructure, the much greater use of employment-intensive methods could, therefore, multiply the positive social and socio-economic effects of such expenditure without detriment to the public purse. Given that the source of funding is provided by the public sector and employment-intensive methods are efficacious, it seems silly of government not to take advantage of being the client to insist that its implementing agencies find ways and means of constructing high-standard infrastructure and achieving at least one major socio-economic objectives, namely, employment creation, which would also contribute to the achievement of other socio-economic objectives.

For governments anxious to find ways to generate employment opportunities, the fact that employment-intensive methods can be cost competitive should encourage them to develop policies to expand such work. As importantly from a policy perspective, the results, taken together with earlier research, suggest that even higher levels of employment-intensity are economically efficient, which leads to the question: Where else in the economy can so many employment opportunities be generated for an equivalent economic investment?

Implicit in the above discussion, is the need to translate the potential into large-scale implementation in order to have a tangible effect upon employment generation and poverty alleviation. In this respect there are many lessons to be learnt from the rural road experience (as will be seen in Chapter 2). The sensible consideration of long term, large-scale implementation means that there has to be something worthy of

replication. This book focuses upon the depth of work that has to be done and the attention to detail required to translate a potential into reality.

The book is structured in four parts. Part One - Chapters One to Three - provides an overview of the subject leading to a methodology for the serious consideration of employment-intensive methods in major civil construction as a whole. Part Two - Chapters Four to Eight - provides details regarding the research and implementation which has been carried out in relation to the material and technology which has been subjected to the closest scrutiny: Waterbound Macadam Basecourse. Part Three - Chapters 9 to 13 - describes and discusses the work that has been carried out in relation to other materials and technologies in the road sub-sector. Part Four - Chapters 14 to 17 - discusses a range of issues to which attention must be paid if formally established contractors are to become a part of delivery. The remainder of this chapter will summarise the contents chapter by chapter.

1.1 PART ONE: OVERVIEW OF EMPLOYMENT-INTENSIVE CONSTRUCTION METHODS

"***From Context to Programmes: Concepts, Potential, Principles, Issues/Lessons and Guidelines***" - Chapter 2 - summarises the argument and evidence which suggests that the public sector should consider greater use of employment-intensive methods for high-standard infrastructure. Starting with greater detail regarding the South African context within which there is a need to generate employment, the chapter provides an overview of the development of employment-intensive construction. Following a definition, the main concepts underlying late 20th century's interest are outlined; these include the importance of work in its own right and as a means of subsistence, yet the need for technical feasibility and economic efficiency. A brief summary is provided of the theoretical research and field implementation: this leads to the delineation of the basic principles of employment-intensive construction. Based upon these principles, several large-scale programmes for the construction and maintenance of low-cost, low-volume rural roads have been implemented in sub-Saharan Africa. This work highlights the scale of operation that has been achieved in one sub-sector of civil construction; i.e. the concepts and principles have not been restricted to the ivory tower of academic analysis but have been translated into large-scale reality that has prevailed for a long time. Reasons for the success of these programmes have been derived partly to provide a base with which to compare developments elsewhere. They also illustrate the number and variety of issues that require consideration and the need for attention to detail and perseverance. As importantly, taken together with consideration of other less successful, large-scale endeavours, the lessons learnt have implications for the large-scale, long-term implementation of other employment-intensive possibilities. A long-term programme approach is required (by contrast to the once off projects which are the norm for the construction industry). Such a programme should be treated with a long-term perspective and thoroughness usually accorded to mammoth projects such as 3 600 MegaWatt power stations. In addition to technical feasibility and economic efficiency, the range of aspects requiring fresh attention would include: planning, design, specification and contract documentation, training, wages and conditions of employment.

It is considered that the factors influencing large-scale success should always be borne in mind during exploration of potential. They provide a reminder of the broader social, economic and technical context within which the long-term objective is being pursued. To repeat, unless there is a potential for large-scale implementation, small-scale projects will not have a discernible effect on either employment generation or poverty alleviation. Sensible consideration of long term, large-scale implementation means that there has to be something worthy of replication.

Chapter 3 is titled "***Choice of Technique Analysis and Applications to High Cost, High Standard Infrastructure***". Theoretical and practical research in South Africa has shown that there is indeed considerable potential in other sub-sectors of civil engineering; in particular the construction of high-cost, heavily-trafficked roads. However, each stage of investigation requires much greater expenditure: a methodology is needed to guide decision makers regarding such expenditures and be used to evaluate results. During the 1990s, research into the use of employment-intensive methods for the construction of high-standard roads led to the formalisation of an analysis to investigate technical feasibility and economic efficiency: the Choice of Technique Analysis. A rationale for the methodology will be followed by a description of it. A summary will be provided of its application to one material and its associated technology. The analysis has been applied, in part, to several materials and technologies. An analysis has also been carried out of the potential across a wide spectrum of sub-sectors in civil construction. The results will be summarized. It will be seen that in several sub-sectors - roads, dams, canals, stormwater drainage - not only is there a potential to significantly increase the opportunities for employment, but the proportion of expenditure on labour would amount to a significant proportion of expenditure on materials, equipment and labour as a whole.

Having provided the basis for continuing investigation, the next ten chapters deal with various aspects of different materials and technologies applicable to two components of a high-standard road prism: the base-course and the wearing/surfacing course.

1.2 PART TWO: WATERBOUND MACADAM BASECOURSE: A MATERIAL AND A TECHNOLOGY

Chapter 4: "***Structural Properties and Behaviour of Macadam Pavements***". Until the early 1960s most base courses in South Africa were constructed using a material and labour-intensive technology known as Waterbound Macadam. Since then it has been replaced by crusher-run, which is constructed using capital-intensive methods. Chapter Four describes and discusses the theoretical and laboratory research, which has been carried out to investigate the technical feasibility and economic efficiency of re-introducing labour-intensive Waterbound Macadam. The original suggestion for investigation of the potential of this material and technology stemmed from the South African firm of James Croswell and Associates. The early work concluded that the use of Waterbound Macadam resulted in a superior product to that of crusher-run and (as we will see in Chapter Three) generated over ten times more employment per unit of expenditure. It provides the intellectual basis for recommending field implementation and investigation. These will be dealt with in Chapters Five to Eight; the location, date and length of road are summarised in the table below:

Table 1-1 Field implementation and investigation of Waterbound Macadam

Location	Date	Length
Xavier Street Johannesburg	1994	180 m
Club Street Johannesburg	1995	600 m
Soweto	1991-1997	12km
N1: Matoks to Louis Trichardt	1997-1999	13km
Potgieter, Hattingh and Raspi (various locations in South Africa)	1997-2002	over 400km

More recent theoretical, laboratory and field research have provided an even more thorough understanding of the reason for the superior performance of the product. The various research approaches, focusing on establishing the relevant material parameters, such as angle of internal friction, cohesion and stiffness, to enable more sophisticated design methods to be used, are presented and discussed. These parameters were investigated through laboratory research, field investigation of old Macadam pavements still in service and full-scale experimentation. Furthermore, the positive results of these various research efforts have provided the basis for the development of, and large-scale experimentation with various other types of Macadam, most notably Slurry-Bound and Composite Macadam. This research work has been substantiated by the results of field implementation outlined in the next four chapters.

Chapter 5: "***Performance of Waterbound Macadam Pavements: Case Study in Johannesburg, South Africa***". In 1994 and 1995 the former Greater Johannesburg Transitional Metropolitan Council constructed two pilot projects with a employment-intensive method utilising Waterbound Macadam base courses. One Macadam basecourse was placed on a granular subbase (Xavier Street) and the other on a bituminous subbase (Club Street). A number of technical issues were investigated, among them the in-situ Macadam properties, the construction tolerances and expected performance. Since this initiative, a number of Waterbound Macadam projects have been completed, complementing the development of guidelines for the design and construction of these pavements. A case study was conducted in 2001 on the two pilot project pavements that were approximately five years old, to assess their short-term in-service performance and to re-visit the expected structural capacity by applying state of the art techniques in the analysis of these layers.

Chapter 6: "***Employment-Intensive Urban Residential Street Construction - An Evaluation of the Soweto Experience 1992-1996***". Following on from the earlier theoretical and laboratory research Chapter Six describes and discusses the experience obtained during road contracts in Soweto over a five year period from 1992 to 1997. While base courses were constructed using Waterbound Macadam, analysis was carried out of all the components involved in residential street construction: excavation, road bed preparation, layer works, base courses, kerbing, stormwater control and surfacing. In relation to these components a framework for increasing employment opportunities was developed. The chapter describes and comments on the different materials used, construction methods and contractual arrangements. Employment generation figures obtained during the period are compared and show that the portion of the total construction cost including management costs retained in the community has consistently been over 25%. This is significantly above the average for paved roads of about 10%. For the Klipspruit project, analysis showed that a substantial proportion of the construction cost (27%)

went directly to labour and if the Soweto-based management support and site staff are included 37 to 43% was retained in the broader Soweto community. Even the so-called *Fast Track* projects achieved labour contents of between 21 and 34% of the total construction cost (including management costs).

Two major areas of employment creation were created during the projects. The first was base course construction and kerbing; the other was in the excavation and layer works portion of the contracts. The sections involved in the construction of the basecourse, kerbing and related works are ideally suited for emerging contractors and allow them to participate in the road building. The necessary skills can be learnt in a short time if the contractor does not have them. The barriers to entry, which include a lack of finance and equipment are removed. No heavy equipment, except for a roller, which can easily be hired, is necessary and a small local business is created in embryo. If the road building in an area is part of a programmed approach so that there is continuity of work over a period of years, the skills that the contractor acquires mature and the emerging contractors gain the experience necessary to expand. This has been seen as emerging contractors from the earlier contracts in the Soweto Contractor Development Programme have joined together and are now bidding against the established contractors for the work with which they are familiar.

Chapter 7: "***Employment-Intensive Aspects of the Rehabilitation of the Great North Road: N1-28 Matoks to Louis Trichardt, South Africa***". In Chapter 3 a Choice of Technique Analysis was carried out on the proposed reconstruction of 53 km section of the N1 highway between Matoks and Louis Trichardt in the Northern Province. The principal conclusion of the report (T786) was:

> *"There is potential to substantially increase the labour content of road construction utilising labour-intensive construction methods"*

The consultant, Van Niekerk, Kleyn and Edwards (VKE) was appointed to produce revised design and tender documents and to supervise the construction. McCutcheon was appointed for advice on labour-intensive matters during construction only, i.e. he was not involved in the design preparation of the tender document. The contract started on 9 December 1996 and was substantially completed by 18 December 1998. Chapter Seven provides an abridged version of the "Report on the Labour-intensive aspects of the rehabilitation of the N1-28: Matoks to Louis Trichardt" which was submitted by McCutcheon to VKE in December 1998. The chapter is structured as follows:

- *Introduction and background*. An analysis of the tender document including a comparison of the labour-intensive and contractor development terms to the recommendation of the T786 Report.
- *An analysis of actual construction*: the community involvement and training are briefly described before the labour-intensive and contractor development work actually implemented is compared to the tender awards. Comments are made based on observations and work studies that examined methods and measured productivities. In several instances the Contractor was advised as to how to reorganise the work. General comments and observations are made in several headings.
- *Conclusions* are drawn from the analysis of the tender, the construction process and its management. Recommendations are made for future work,

based upon experience gained during this Contract. The amount of labour-intensive work billed in the tender (8% of tender sum) was significantly less than envisioned in the 1995 T786 report. In relation to the contract itself, the amount of labour-intensive work done was considerably less than that billed (43% of the amount billed). Over 80% of this work was on one item only, Waterbound Macadam. In the contract the specified high quality was achieved at reasonable production rates. On-site work-studies showed that productivities could also be improved. Thus in relation to this component productive employment was generated as intended.

Chapter 8: "***Evaluation of the Employment-Intensive Macadam Construction Technique With Special Reference to Franchising***". This chapter will consist of an investigation and evaluation by the South African firm of Potgieter, Hattingh & Raspi (PHR Inc.) into the different types of Macadam, their uses and applications, with particular reference to their use in employment-intensive construction methods. Reference to PHR's work has also been made in Chapter Four.

1.3 PART THREE: OTHER ROAD CONSTRUCTION MATERIALS AND TECHNOLOGIES

Chapter 9: "***Emulsion Treated Base Courses for Employment-Intensive Construction***". The subject of Chapter Nine is a promising relatively new technology in employment-intensive road engineering called the Emulsion Treated Base. This is a low-grade gravel material treated with a low percentage of bitumen emulsion (1.5%) and cement to help the emulsion break. The emulsion binds the material, increasing its strength and durability. The biggest advantage of this method is that it provides a viable alternative to cement stabilisation, which is a highly capital-intensive construction method and very widely used in South Africa.

While the behaviour of this material is not yet fully understood, it performs very well in the field and in field investigations with the Heavy Vehicle Simulator. Emulsion Treated Bases can easily be constructed using labour-intensive methods and the construction process is suited to small contractors, because it can be done by small teams, and requires only light equipment. As it is a semi-bound material, which means that its surface generally remains in good condition if exposed to traffic when the surfacing is not applied immediately, the entire construction process more is flexible. The chapter describes the current design methods, provides guidelines on construction methods and quality control and discusses some of the economic considerations.

Chapter 10: "***The Use of Sulphonated Petroleum Product Stabilisers in Employment-Intensive Road Construction***". Until recently the use of ionic chemical soil stabilisers seemed to be "hit or miss". A paper by Paige-Green and Bennett explained that these stabilisers only work on soils containing reactive clay. Chapter Ten describes and discusses research, which confirmed these findings, took it further and related it to employment generation in construction. It was shown that a CBR test, which can be done in many road soils laboratories, can be used to measure the change in strength caused by the treatment of the soil with a chosen ionic stabiliser.

Field trials showed that ionic stabilisers can readily be applied labour-intensively. These stabilisers could improve marginal material to road-building standard and this could further reduce the dependence on machinery by reducing the need to transport quantities of high quality gravel. In the first place this would increase the labour-intensiveness of the construction process. Secondly, it would increase the labour-intensiveness in relation to a higher standard of construction than would have been possible using untreated in-situ material. Thirdly, greater use of in-situ material for higher standard product would reduce dependency on high standard gravel which is becoming increasingly scarce which results in large transport distances and, in turn, higher capital-intensiveness and costs. Additional research has shown that the use of SPPs is compatible with labour-intensive methods from an environmental and health and safety viewpoint.

Chapter 11: "***Employment-Intensive Concrete Block Pavement Construction for Upgrading Township Roads in South Africa***". In 1998 an overview was carried out of the situation regarding the use of labour-intensive materials in concrete block pavement construction. The chapter was generated partly by South African interest in concrete block paving, but also stemmed from knowledge that it is still widely used in parts of Europe - in particular in the Netherlands. In other words, this extremely labour-intensive method of high-standard construction is also used in countries where very high wages are paid.

The report was the result of a study of literature and project reports, interviews with experts, and site visits. Concrete block pavement construction is a very popular up-market, aesthetically pleasing method of pavement construction in South Africa. However, it has not been fully accepted as a good alternative for high quality road construction where load bearing capacity is the prime consideration. The chapter reveals that concrete block pavements are particularly suitable for application in townships for three main reasons: employment generation, wide applicability in poor subgrades and low maintenance cost. For successful overall acceptance and implementation a programme-based approach towards formalisation, development and implementation is necessary.

Chapter 12: "***Labour Friendly Bituminous Surfacing and Wearing Courses***". Bitumen itself is the product of a capital-intensive process. Conventional construction of a wearing course using bitumen is also highly capital-intensive. Until a less capital-intensive method of producing bitumen (or a viable alternative), the main potential for an increase in employment generation lies in the exploration of the following routes:

- The construction methods need to be examined to see where, and how, greater use may be made of employment-intensive methods.
- The chemistry of bitumen should be examined to see whether it may be altered to make the material more amenable to being used by labour.

Taken together, these two explorations could also lead to methods and materials that could be adopted by small contractors for the employment-intensive construction and maintenance of high standard wearing courses/surface courses.

The introductory section of Chapter Twelve discusses the implications for bituminous surfacings of each of the following: quality, technical feasibility, organisation, training and safety. It then devotes a section to each of the following

materials and techniques: surfacing, seals, slurry seals, cold-mix asphalt and hot asphalt. In relation to each of these, after a brief introduction, it provides a concise description and discussion of the current state of knowledge with respect to the following factors: design, aggregate, binder, construction methods, level of contracting skills and productivities.

Chapter 13: "***Design and Construction of Hot-Mixed Asphalt Surfacings for Employment-intensive Construction***". The surfacing of roads with hot-mix asphalt is common on high traffic roads and/or high strength pavements. In urban areas of South Africa, hot-mix asphalt is used for the structural and functional surfacing of major distributor roads and the functional surfacing of most residential streets. Hot-mix asphalt is a carefully proportioned mixture of selected coarse and fine aggregates, mineral filler and a bituminous binder. It is mixed and laid hot for ease of handling and to ensure compaction can be achieved while the bitumen is still warm and of low viscosity.

Further discussion in Chapter 13 delves into the early construction of hot-mixed asphalt which was done by hand. Mechanical spreading of asphalt mixes did not occur until 1928. Since then there have been substantial changes in traffic loads, and riding quality standards. These have been accompanied by changes in hot-mixed asphalt design and construction. Asphalt roads are now built using plant based construction techniques for reasons of speed, quality, economy, worker safety, and preference. The typical asphalt industry position on the suitability of asphalt for hand or labour-intensive construction is that "*hand work should be limited to correcting known paving deficiencies and spreading asphalt in areas inaccessible to the paver*".

This dearth of hot-mix asphalt in employment-intensive construction has arisen because plant-based construction dominates the asphalt industry. The use of plant based methods is probably essential for asphalt surfacings on high speed roads where strict finishing tolerances are needed to ensure good riding quality, and there is a requirement for a high daily tonnage to be laid. However the technologies are available to design and construct hot-mix asphalt surfacings for employment-intensive construction that can meet good quality standards, and its use can be extended beyond the present limited applications to include surfacings on low volume roads and in urban areas.

1.4 PART FOUR: DELIVERY AND CONTRACTOR RELATED ISSUES

The main focus of the book is the potential for increasing the use of employment-intensive methods during the provision of high-standard infrastructure; but this will remain of academic interest and relatively small-scale action, unless there is large-scale usage of what has been discovered. Small scale development is important in its own right: employment-intensive methods will generate employment in the places where they are used and allow entrepreneurs who do not have access to capital to engage in the construction industry. Equally, these methods would enable countries without a local established construction capability to be less reliant upon expatriate organizations for the provision of infrastructure. However, delivery on a large-scale could only be through construction that would be sophisticated in technical, financial, managerial and organisational terms. This could be provided by an in-

house public sector capability. But a combination of inefficiency in such capabilities and general suspicion about in house departmental construction, as such, means that at present, in South Africa, large-scale delivery could only be provided in the near future by established formal sector contractors. This would mark a critical point of departure from the way employment-intensive methods have been used to date.

Chapter 14: "***Employment-Intensive Construction Methods and the Use of Contractors***". The principles and guidelines governing employment-intensive construction and large-scale implementation would also apply to large-scale implementation using private sector contractors. But the existing nature of the socio-technical system - capital intensive - means that other factors would need to be taken into consideration. Change is difficult. However, the combination of the funding by the public sector and the contract itself provides the opportunity for bringing about change. Both the macro and micro contractual environment would need to be modified in order to facilitate the use of employment-intensive methods by established contractors. In the first place there has to be an accommodation between three main parties: public-sector, private sector and labour. In Chapter 14 a brief summary is given of developments in South Africa which led to one such accommodation: the "Framework Agreement for Labour-intensive Construction in Civil Engineering". The elements of the agreement indicate the issues that need to be taken into account. Many of the key issues related to the employment component of the equation have been addressed in the Amendments to the labour legislation which were gazetted in January 2002.

Chapter 15 "***How to Activate the Power Inherent Within the Contract***". Actual construction of high-standard infrastructure results from various combinations of the triarchy of client, consultant and contractor. The debate continues as to the balance between the public and private sector and which combination of the triarchy is most effective. It is not the purpose of Chapter 15 to discuss such issues. We will discuss aspects of the construction process which will require attention whatever combinations are used to involve private sector contractors: contract, prejudice, pre-feasibility report, contract documentation, and the need to bring the environment for employment-intensive contracting into line with that used for conventional contracting. The latter includes decision rules regarding tenders, the tender process, appraisal of submitted tenders, and monitoring of performance.

The focus of chapters 14 and 15 has been on established contractors as it would require large-scale implementation to have a perceptible impact on national statistics. However, all the issues discussed would be pertinent to both large formally established contractors and to smaller entities, such as those rather loosely termed Small and Medium Enterprises (SMEs). Given this situation and the current attention at policy making level to small contractor development, an appendix to Chapter 14 provides a summary of the major issues surrounding the debate on small contractor development with particular emphasis upon the role of employment-intensive methods in this context. It will be seen that many of the suggestions regarding the fostering of employment-intensive construction will apply with equal force to small contractor development.

Chapter 16, "***Group Tasks and Group Balancing***", focuses on another critical element that is necessary to align employment-intensive and conventional

contracting: the preparation of estimates and budgets. In turn this is linked to good site organisation regarding Group Tasks and Team Balancing. Individual tasks and balance between such tasks have been the basis for site organisation for low-cost, low-volume rural roads. For more sophisticated work, it has been necessary to use group tasks for operations, where a balance is achieved between the activities which comprise an operation, and then the team balance between the various operations which comprise a project. Chapter 16 discusses and provides examples of methods for setting Group Tasks and obtaining a Team Balance. As importantly, the chapter provides a methodology for calculating the labour component of the contract. A section on measurement of the hardness of material will be appended to this chapter, as it has been found to be a major stumbling block to good management.

In Chapter 17, "***Summary and Closing Comments***", the main conclusions which have been reached from the argument and evidence presented in the book will be summarised, together with additional closing comments.