Editorial

This first issue of ORiON Volume 23 contains six interesting operational research papers ranging from methodological topics and applications in linear and goal programming as well as graph/network theory to potential future contributions as well as historical perspectives of operations research (OR) in South Africa. However, what makes this issue special is that it is dedicated to Emeritus Professor Gerhard Geldenhuys, a pioneer of OR in South Africa on the occasion of his 70th birthday — see the official dedication following directly on this editorial. All papers in this issue have been dedicated to Gerhard by the respective authors, whilst being subjected to the normal procedure of blind and anonymous peer review.

In the first paper of this volume, titled *The essential multiobjectivity of linear programming*, Theo Stewart argues lucidly and in no uncertain terms that non-trivial real world problems typically involve multiple objectives. He maintains that the simplistic (and often popular) approach of combining objectives in linear form may generate highly misleading and biased results, and is poor operational research practice. He then goes on to illustrate such biases by means of a simple example, and demonstrates that two simple approaches based on goal programming and piecewise linear value functions may largely resolve the problem. Although the suggested modelling approach requires careful attention to problem structuring, it is typically easily implemented by use of standard commercially available LP packages. In short, the paper contains a valuable lesson to inexperienced (and perhaps even some experienced!) operations researchers.

The second paper, by Daniel Seegmuller, Stephan Visagie, Hennie de Kock and Wessel Pienaar titled *Selection and scheduling of jobs with time-dependent duration*, contains two mathematical programming models (both with multiple objective functions) for solving four related categories of job scheduling problems. All four of these categories have the property that the durations of the jobs depend on the implementation time and in some cases the preceding job. Furthermore, some jobs (restricted to subsets of the total pool of jobs) may, to different extents, run in parallel. In addition, not all the jobs need necessarily be implemented in the given time period. The models emanate from a real case where an optimal sequence of tests to be performed at a specific test station is sought. Individuals wanting to use the test station must apply to occupy the test station and sometimes may even choose the time at which to carry out the test. This results in a pool of tests and the management of the test station must select a subset of these tests and determine a sequence in which the tests should be performed in order to maximise income. The authors find that formulating the resulting scheduling problem as an integer programming problem is relatively complex, but has the advantage of being very flexible. Many different scenarios may thus be modelled and additional constraints limiting job implementation times and precedence may easily be accommodated. Multiple objective functions may also easily be incorporated by recursively running the same application with different objective functions and additional constraints imposed by enforcing previous objective function values. However, the associated solution times increase drastically as the pool of jobs and number of periods increase — to the extent that the number of binary variables and constraints in realistic scheduling problems become too large for commercial software to solve within an acceptable time frame.

In the third paper titled *On the $\Delta(d)$-chromatic number of a complete balanced multipartite graph*, Alewyn Burger, Isabelle Nieuwoudt and Jan van Vuuren consider the problem of finding the minimum number of colours with which the vertices of a complete, balanced, multipartite graph may be coloured such that the maximum degrees of all colour class induced subgraphs are at most some specified integer $d \in \mathbb{N}_0$. The minimum number of colours in such a colouring is referred to as the $\Delta(d)$-chromatic number of the graph. This problem has its roots in applications conforming to the generic scenario where users of a system are in conflict if they require access to some shared resource. These conflicts are represented by edges in a so-called resource access graph, where vertices represent the users. An efficient resource access schedule is an assignment of the users to a minimum number of groups (modelled by means of colour classes) where some threshold d of conflict may be tolerated in each group. If different colours are associated with different time periods in the schedule, then the minimum number of groupings in an optimal resource access schedule for the above set of users is given by the $\Delta(d)$-chromatic number of the resource access graph. A complete balanced multipartite resource access graph represents a situation of maximum conflict between members of different user groups of the system, but where no conflict occurs between members of the same user group (perhaps due to an allocation of diverse duties to the group members).

Suppose that at most r units of some commodity may be positioned at any vertex of a graph modelling some portion of a certain facility infrastructure and that at least s ($\geq r$) units of the commodity must be present in the vicinity (*i.e.* in the closed neighbourhood) of each vertex of the graph. Then the smallest possible number of commodity units that may thus be deployed over the graph vertices is called the *$\langle r, s\rangle$-domination number* of the graph. In the fourth paper of this issue, titled *An algorithm for the $\langle r, s\rangle$-domination number of a tree*, Ernie Cockayne, one of the fathers of graph domination theory in the 1960s, presents (and illustrates by means of numerical examples) an efficient algorithm for determining the $\langle r, s\rangle$-domination number of an acyclic, connected graph. The algorithm runs in $O(n^2)$ time, where n denotes the order of the graph. The algorithm is significant, for at least three reasons: (i) the problem of determining the $\langle r, s\rangle$-domination number of a general graph is NP-complete, (ii) a (spanning) tree is the most economical connected backbone structure underlying any connected graph, and (iii) operational research applications of $\langle r, s\rangle$-domination abound (for, example, the commodity may be monitors, who have to audit some system layout, where at least s auditors are required to observe the station represented by each vertex of the graph model, but where no station can accommodate more than r auditors — perhaps due to cost).

The penultimate paper, by Philip Fourie, titled *Operations research and development* contains an overview of the Reconstruction and Development Programme (RDP), which today still embodies the vision of development in South Africa associated with the political transition in 1994. The efforts of the Operations Research Society of South Africa to help with the implementation of the RDP are described, as well as the involvement of the international OR community with respect to the promotion of development, especially via the International Federation of Operations Research Societies. The paper eloquently contrasts *sustainable development* (which deals specifically with a long-term view of development benefiting the community) with *economical development* (where the primary purpose is the enrichment of the developer and its benefits to the community are often doubtful)

and makes some suggestions as to how ORSSA and its members may help to promote development in South Africa, by considering the needs identified in the RDP as well as relevant OR methods that may be employed to address these needs.

In the final paper, titled *Operations Research at CSIR: A brief history through cases*, Hans Ittmann, Esbeth van Dyk, Isabel Meyer and Johan Janse van Rensburg take a historical look at the development of OR at the CSIR over the last 45 years. Apart from work in the mining industry during the 1950s, the first real OR group in South Africa was established at the CSIR in the early 1960s. Those initially involved in this group — including Gerhard Geldenhuys in a pivotal way — played a significant role in establishing OR at various universities in South Africa. The OR group at the CSIR still exists today and in this paper the authors present a brief history of this group and endeavours to provide a glimpse of some of the projects conducted over the many years since its establishment. The projects include the the Maize Board transportation problem (1962–1988), OR for the military (1970–1985), simulating coal export channels for SASOL (1992/3), trackless mining simulation (1993), train scheduling (1995/6), OR applications in the South African Police Service (1998–2000) and OR applications in the South African fresh fruit export industry (2002–2004).

As always, I am confident that the diversity and quality of the six papers in this issue are such that each reader of ORiON will find something suiting his/her particular tastes and interests. I would like to thank the fourteen authors who contributed their interesting work to Volume 23(1) of ORiON — their support of ORiON is invaluable — the readership of ORiON are indeed encouraged to continue utilising ORiON as publication vehicle for their research. My sincere thanks also go to the twelve anonymous referees who generously gave of their time to evaluate the papers in this issue timeously and in a very professional manner; they have made valuable suggestions which have led to substantial improvements in the quality of papers in virtually all cases.

I would also like to thank the newly appointed editorial assistant, Adri van der Merwe, who has made my life considerably easier by taking over many of my administrative duties as editor, thereby freeing my time so that I can now concentrate on editing issues and consolidating referees' reports. Thanks also to the Operations Research Society of South Africa for making Adri's position possible by way of financial assistance provided.

Finally, my sincere thanks to associate editor John Hearne, who managed the refereeing process of one of the papers in this issue on my behalf, and to the business manager, Stephan Visagie, for his usual high standards typesetting the manuscripts in LaTeX and for overseeing the time–consuming publication process of this issue.

Jan van Vuuren
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