THE ECONOMICS OF QUARRY DEVELOPMENT.

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Efficient quarry development and management, in my opinion, rank high in the economic expansion and orderly growth of cities, urban areas, and counties of this country.

Quarry products vary widely but all are required to fill particular needs. The quarry is in fact a factory which must be developed and controlled to the same degree as any other large industry.

The problems of wear & tear and maintenance may even exceed those of conventional industry, but Management must be of the highest quality and this is common to any profitable business in a competitive market. It has been proved time and again that if management is not efficient the undertaking will be a financial failure.

It may surprise you to learn that in my book No. 1 in quarrying is tidiness and cleanliness. By this I mean clean floors and benches, dustfree haul roads, neat offices, workshops and workers' facilities, absence of litter, such as old iron drums, timber, loose stones etc. Rock faces should be free of hanging rocks and debris.

All these and many more add up also to increased safety and reduction of wear and tear on vehicles, machines and personnel.

One can usually sum up the efficiency of management and its success by the first impressions one gets on entering a quarry and these are the points I look for.

Most quarries have at least three basic types of material - strippings, second-grade or deteriorated rock and first grade rock. Each must be disposed of efficiently, for each contributes negatively or positively to the profitability of the quarry.

The price of your top-quality aggregates will depend on how well you sell your lower quality material and how economically you can get rid of your stripping.

To my mind, New Zealand engineers specify too much top-grade metal where second-grade metal would fulfill the required duty. I feel that if this trend is not arrested the price of our finest aggregate must rise, and this country is not in a position to pay for unwarranted luxuries.

Now a word of warning about over-full production. It is a mistake to run all your plant at 100% capacity for every working hour of the week. You must either provide additional machines for stand-by duty or stop production at pre-determined intervals to enable essential maintenance to be carried out.

Above-optimum production causes fatigue in crushers, screens and ancillary plant. It will also cause over-loading of these units and will produce non-uniform products outside specification limits. This will upset clients and could well result in loss of good customers.

I need not remind you that quarrying is full of problems but also full of interest. Problems exist only to be overcome and this can only be done by positive and efficient management.

The production of sand, gravel and crushed rock for building construction, roads and ballast ranks high in major New Zealand industries, both in quantity and value.

The following table is compiled from production figures taken from the N.Z. Year Book for 1966 and 1968. (The production for the year 1968 is estimated.)

		1963	1964	1965	1966	1968
	Sand, crushed rock, gravel etc. for building aggregates.					
	(a) TONS:	3,941,000	4,408,000	5,679,000	5,622,000	6,000,000
	(b) VALUE:	$2,991,000	$2,778,000	$7,850,000	$7,771,000	$8,400,000
2.	Sand, crushed rock, gravel etc. for Roads and Ballast.					
	(a) TONS:	15,612,000	14,991,000	19,486,000	22,883,000	25,000,000
	(b) VALUE:	$13,566,000	$14,666,000	$17,120,000	$19,737,000	$21,600,000
3.	Total for Building Aggregates, Roads and Ballast.					
	(a) TONS:	19,553,000	19,399,000	25,165,000	28,505,000	31,000,000
	(b) VALUE:	$16,557,000	$17,444,000	$24,970,000	$27,508,000	$30,000,000

The values are assessed at quarry or gravel pit.

The total value of these materials for the year 1968 was approximately $30,000,000 which, by any standard, represents very big business.

It is roughly equivalent to the total amount spent in 1968 by the National Roads Board on highway construction throughout New Zealand.

And yet this is only the ex quarry value; when cartage and placing costs are added the resultant total figure probably exceeds the total income of the National Roads Board for that year.

The economics of this tremendous industry are therefore worthy of close and continuous study. Expansion involves great capital outlay and is generally only justifiable when increased production and lower unit costs are thereby made possible.

For example a reduction of only three cents per ton over the total production for 1968 would effect a total economy of nearly $1,000,000.

Careful planning, development and maintenance make such economies possible and assist materially in achieving the prime objective of any industry - to create consumer demand for its products and attractive profits for its shareholders.

To do this on a continuing and preferably rising scale, planning must be directed towards production of saleable products in an area where demand is more or less constant or expanding.

Because of advances in technology the properties of materials and therefore their likely behaviour in pavements or structures under a variety of conditions, are much better known as are also the forces acting on them.

In the last decade in particular the lack of appreciation by engineers and designers of the quality of the aggregates with which their structures are so intimately involved has led to a series of failures or apparent material distress, and invariably the aggregates have been blamed. Invariably also close examination of the history of design, specifications and construction point to human fallibility in design and supervision as the primary cause of such failures.

However on the credit side the growth in our knowledge of the basic qualities to look for in country rock and of the methods now required to produce high quality aggregates from it for any specific purpose is now much better appreciated because of these failures.

New Zealand is a "young" country geologically-speaking and our rock formations differ widely in origin and character even in adjacent areas. It is therefore impossible to write a so-called "standard" specification for all types of aggregates and still do justice to economics and the quarrying industry.

This difficulty is compounded by the diversity of "end-results" suited to particular needs.

The endless search for economy in construction in an environment subject to a spiralling wage structure, rising transport costs, and involving ever increasing plant and material investment has produced many effective and diverse construction techniques.

To name but a few we have:

(a) soil cement stabilisation for strengthening weak subgrades,

(b) cement-treated basecourses for strengthening pavements involving a maximum of locally produced products,

(c) bitumen-bound basecourses for a similar purpose, but incorporating an imported product,

(d) pre-stressed and post-stressed concrete for structures requiring high-quality aggregates, concrete manufacture and placement,

(e) masonry-block for structural and decorative use.

Just over the horizon we see increasing use of light-weight aggregates, and growing use of precast products and off-the-site construction of a multiplicity of elements for later assembly on site.

Wherever road pavements and concrete construction are involved, the quarrying industry, as the developing agent of the raw material and of the processing sequences becomes the key to quality control of materials and a major factor in the control of costs.

The economies of quarry development, including processing and transport of materials, is of prime importance to the producer who must develop a viable industry, generally in competition with others equally competent and astute.

Economics are functions of end use of materials, location of quarries, geological structure and quality of rock, and transport restrictions from supplier to job-site.

It is therefore manifestly impossible to lay down a formulae which will encompass all these variables. Nevertheless it is possible to lay down certain guide-lines which are common to all rock-products producers when establishing a new quarry.

The following factors require rational appreciation when planning for a new quarry as a long term or permanent establishment.

(a) Determine the immediate market requirements and assess the market potential over a period of at least ten years.

(b) Consult the New Zealand Government Year Books and annual returns of the Mines Department to evaluate past demand and growth as an aid in assessing possible future growth.

(c) Determine the area over which your proposed quarry would exert a "sphere of influence" by supplying the market at competitive rates, assuming the rock available is likely to meet specifications.

(d) Study the roads and highways available for transport from quarry to market. Class I roads permit appreciably lower unit rates than Class II roads, but gradients and traffic bottle-necks also affect costs.

(e) Study the available geological data of the area, and discuss the potential of the proposed quarry with D.S.I.R. geologists and scientists, and engineers from the Ministry of Works.

Research of this kind will not replace later detailed investigation but it may obviate much costly but useless investigation or conversely reinforce sober judgment of future possibilities.

(f) With this information reinforced by a study of aerial photographs determine a site or sites which would justify more detailed investigation.

(g) Confirm, or otherwise, your preliminary assessment by a walk-over survey of the properties involved, preferably with the aid of contour maps available from the Survey Department.

(h) If the prospects appear promising take preliminary steps to secure the properties by option to purchase or lease or by payment of royalties, subject of course to final assessment after further investigations.

(i) By preliminary exploratory core drilling define the quality and extent of available rock and if the quantity and quality appear satisfactory carry out a cost analysis and feasibility study.

(j) If these studies justify the proposal carry out detailed drilling to determine within close limits the total quantity of high-quality and sub-quality rock available, the area of land required for quarrying, processing, stockpiles, workshops and ancillary services.

(k) Establish the grades of crushed and uncrushed products to be produced. This will be governed by the assessment of the market demand mentioned earlier in (a).

(l) Design the quarry:-

i. Stripping and disposal of overburden

ii. Quarrying and disposal of second-class rock.

iii. Crushing and screening design and layout including subsequent processing.

iv. Transport or conveyance to stockpiles and stockpile layout.

(m) Establish the capital requirements which may also involve housing for key personnel.

(n) Draw up labour and production budgets.

(o) Estimate profitability.

(p) Plan and carry out a public relations programme aimed at optimum sales over a pre-determined period.

Investigation of the economics and future potential of an existing quarry requires a different approach and must be done as a continuing exercise, with annual reviews if the particular industry is to maintain acceptable profitability.

Although our knowledge of the behaviour of materials under stress is now quite extensive, it is by no means exhaustive and technologists here and overseas are constantly producing new theories backed-up in some degree by observations of performance in practice.

These theories, even when proved sound, are often the result of having to "make-do" with aggregates of sub-standard quality in the total absence of quality products.

To some extent we in New Zealand have felt the effect of overseas investigations to which must be added the findings of our own technologists acting independently but often in parallel with their overseas counterparts.

This has resulted in a variety of specifications which in general demand fairly comprehensive processing of quarry aggregates to produce the end result.

Often it becomes necessary to import small percentages of other products, for example sand, not economically available from normal quarry processing. The production of aggregates for hot-mix asphalt is a case in point where a basalt quarry may without much difficulty, produce all the aggregates required within its normal crushing and screening set-up, whereas a greywacke quarry would probably have to import sand to make up deficiencies in the fine aggregate sizes. The alternative would require installation of a ball or rod-mill.

The variables involved because of variations in specifications, source of materials and their geological origin make any assessment of establishment requirements difficult.

No two quarries are exactly similar as regards rock type, location, equipment requirements, product demand and accessability to markets. Therefore a detailed outline of the economics which would influence every facet

of quarry development would be manifestly impossible.

However there are a number of factors common to all quarrying operations, which have perhaps received less attention than they deserve but which have a critical effect on the success or failure of the venture. These may be summarised as follows:

QUALITY CONTROL:

During the last decade in particular changes in engineering techniques have been responsible for demands for higher quality materials in the construction of pavements, concrete and asphalts. The resulting specifications demand continuous control both in the production of aggregates and in their placement in the final structure.

It is now essential for a producer of aggregates to establish an up-to-date laboratory controlled by a competent senior technician with one or more assistants.

Equipment to cover all the tests involved in modern construction must be adequate and precise. Test results must be available at short notice and this generally involves rapid field checks of a relatively simple nature followed by tightly controlled laboratory tests for more exact confirmation.

Mobility of personnel and equipment is essential so transport must be provided.

A fully equipped laboratory with a vehicle could involve expenditure of $30,000 to $40,000 for a quarry supplying aggregates for pavements, masonry blocks, asphaltic concrete and structural concrete where responsibility for construction is also involved. However for quality control only of the aggregates, probably $20,000 would be sufficient. Salaries and running expenses could vary from $5,000 to $10,000 per annum.

These costs are fully justified by the security given to the operator in the control of his products and the reliance that the client places on the products because he knows this control is operating.

An intangible but no less valuable advantage is that they keep the owner and his key personnel abreast of modern developments and research in his particular field.

They will soon find that if they are to keep abreast of developments in advancing design, safety factors and economics they will have to identify themselves with the activities of other trades and professions and collaborate to a much greater degree with their counterparts there.

The idea of "splendid isolation" is now obsolete and a degree of integration of interests with others of like minds is not only sound politics but is a low-cost investment that pays dividends.

MARKETING . OF QUARRY PRODUCTS:

This subject has been to some extent the "Cinderella" of all the factors that require attention if success is to be achieved in a quarrying industry.

In New Zealand we have become accustomed to the principle of the lowest price governing the successful quotation and have done little to push our own products on the criteria of both quality and cost.

With a few exceptions salesmanship is practically non-existent in the industry and yet other industries commit a large proportion of their income to this critical sector of their economy.

A large quarry geared to supply most of the aggregates required for diverse use in a city, would list 20 to 30 different types of aggregate, each requiring special attention through quarry processing, stockpiling, transport and delivery.

Average annual expenditure for such a quarry with an annual output of 500,000 cubic yards could exceed $1 million. If only 5 cents per cubic yard were allowed for marketing this would amount to $25,000 annually.

Before embarking on a sales promotion drive the producer must satisfy himself on the following points.

(a) Are we producing the correct materials to satisfy demand? (e.g. size, range and quality.)

(b) Is our plant capable of producing materials to satisfy this demand?

(c) Is our present optimum production in excess of or below requirements for any particular product?

The answers to these questions will indicate whether capital expenditure is required for new equipment, or alternatively, whether some re-arrangement of lay-out is necessary.

It is presumed that the availability of raw material is adequate for expansion if this is warranted.

(d) What is the average selling price for each type of aggregate?

(e) What is the average profit for each type of aggregate?

The producer must decide whether it is better to produce a demand for surplus products or gear production to produce the most saleable sizes.

Competent salesmen are a 'must' for the first, but it is the responsibility of the quarryman to improve his production techniques to achieve the second.

Failure of either party will result in dumped stone, and stock lying idle is a restriction on working capital. It is often necessary to differentiate between sale at a lower price and dumping in the hope of a better sale later.

To determine production cost and selling price, a profit and loss account is required which may be obtained from individual costings and financial information available.

The 'critical path' to final sale may be as follows:

(a) Price,
(b) Delivery service,
(c) Quality,
(d) Customer contact,
(e) Technical service.

A local authority or Government Department is normally expected to accept the lowest price if there is a similarity of product, but quality and service will affect relationships and may often swing the sale your way, even if the price is slightly higher.

Quality is governed by specification, but within the parameters there is a premium for uniformity, shape and for other qualities that may influence the client to take the highest quality although all may be within specification limits.

Customer contact and technical service are a combination of sales promotion and expertise in the merits and use of the product. Although each of these requires a different approach they may often be undertaken by one officer - obviously one who is gifted technically, but also having a sound knowledge of successful selling techniques.

Only by careful planning and analysis of the market potential and current trends may optimum profitability of an enterprise be assured.

Careful planning is essential for all phases of the industry, particularly as its demands on capital are perhaps greater than in most other enterprises.

In conclusion emphasis should again be given to the value of co-operation and exchange of knowledge and ideas, both within and outside the industry, by means of conferences and technical sessions. Particularly in the field of investigation and research is co-operation necessary with technologists in the public service and in private enterprise.

Only in this way may the problems of the producers, the designers, the construction engineers and the economists be mutually understood and resolved.

Acknowledgments:

1. "The Marketing of Quarry Products" by F.P. Luff, Quarry Managers Journal, March 1968.

2. "Some Considerations Involved in Opening a Quarry" by J.K. Mercer B.M.E. A.M.I.E., Aust. Quarry Managers Journal, April 1968.