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Engineering

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N. Z. I. E. news section

A supplement to " New Zealand Engineering " sent to all members of the N.Z. Institution of Engineers

President: R. A. J. Smith, B.E., C. Eng., M.I.C.E„ F.N.Z.1.E.

Secretary: R. W. K. Stevens, C.B.E.

The Secretary's *Newsletter*

MEETINGS of the Executive Committees and of the Council were held on 31 May and 1 June, and the following matters will be of interest to members:

The N.Z.I.E. Environmental Award

A design for the plaque to be presented to the Award winner was submitted by D. Hatcher of Auckland and approved by Council. Quotations for the casting of plaques in bronze are now being obtained.

1972 Conference

The Council approved a draft programme for the 1972 Conference which will be held in the Students' Union building, University of Canterbury, from 7 to 11 February 1972.

There will be no particular theme underlying the Conference programme but attention will be devoted to the problems of metrication and engineering education and research. The Publications Committee expects to be able to provide a wide range of technical papers for presentation.

The Electronics Technical Group

In earlier newsletters it was announced that the Council of the Institution had approved the integration of the N.Z. Eectronics Institute with the N.Z.I.E. as a Technical Group of the Institution, Unfortunately, a number of complications have arisen, connected mainly with the welfare aspects of the Institute's activities, and Council has decided that the integration be deferred until these difficulties have been rsolved.

Technical Group for Chemical Engineering

The inaugural meeting of the Chemical Engineering Group was held in Christchurch on 8 May, when the draft rules were approved and a committee of management elected. Enquiries regarding membership of the Group should be addressed either to the Groups' Hon. Secretary, Dr D. J. Woodhams, N.Z. Dairy Research Institute, P.O. Box 1204, Palmerston North, or to the Institution Secretary.

Professional Interviews, May 1971

There was a record attendance at the Professional Interviews held in May, when ninety-four candidates presented themselves. Eighty-eight candidates were successful, the six failures being attributed to a variety of reasons with no one cause being predominant.

Metrication

Have you received copies of the following bulletins on metrication?

1. "Change to metric in the building and construction industry", 18 January 1971.
2. "An outline of New Zealand's planned conversion to the metric system", 5 April 1971.

If not, write to the

N.Z. Metric Advisory Board,
P.O. Box 10-243,
WELLINGTON.

ANZAC FELLOWSHIPS 1972

Applications are invited from men and women for ANZAC Fellowships. Applicants must be New Zealand citizens of proven ability in their trade, profession or business who wish to further their studies or training in Australia in 1972.

Normally two persons are selected each year to take up ANZAC Fellowships which provide an allowance of up to $A6,000 per annum (plus additional allowances for a wife and children) plus certain tuition and travel costs. Awards are tenable for up to one tear but may be made for a shorter erm to meet the programme requirenents of the selected candidates.

Where all other factors are equal 'reference will be given to candidates under the age of 45 years.

Application forms and further pariculars may be obtained from the Secreary, ANZAC Fellowship Selection Committee, c/o Department of Internal Affairs, Private Bag, Wellington, with whom applications should be lodged before 1 August 1971.

Application forms may be also be)btained from the District Offices of the Department of Internal Affairs in Auckand, P.O. Box 2220, and Christchurch, P.O. Box 1308.

Please note the following correction to the list of Council members published in March. Professor Lu's entry should have read

Professor F. P. S. Lu,
Professor of Management,
Department of Business Studies,
University of Otago,
P.O. Box 56,
Dunedin.

N.Z.I.E. FOUNDATION INVESTIGATION CARD INDEX SYSTEM

This project has been initiated by the National Committee of the New Zealand National Society for Soil Mechanics and Foundation Engineering. It is an attempt to establish local borehole indexes which it is hoped will grow and possibly eventually lead to a national borehole index. Such indexes should be of value to those planning a site investigation in assessing if any previous investigation has been done in the vicinity of a proposed site.

During 1969 index cards were distributed to all N.Z.I.E. branches and a recording system has now been established in most of these. On the card no attempt is made to log the soil conditions found at the site. All that is requested is a site plan showing the approximate position of boreholes and also details of the number of bores, range of depths, types of bores and diameter, the type of soil, sampling done and the names of the soil tests carried out. In addition, the name and address of the holder of the investigation record is listed.

Whether or not the information will be released to the inquirers will remain the prerogative of the holder of the investigation record. The holding authorities for the completed cards in the various areas are listed below. It is intended that the cards be filled in at the time of application for a building permit.

The responsibility for maintaining the card index system in particular areas has been undertaken by the local branches of the N.Z.I.E. and any queries about the operation of the system should in the first instance go to the local branch secretary of the N.Z.I.E. The Wellington office of the N.Z.I.E. has a supply of new cards which are available to anyone at 4.5 cents each.

The locality of the completed cards in various centres is as follows:

Auckland: Geology Department, University of Auckland.

Dunedin: Dunedin City Council (Mr G. G. Dunn).

Gisborne: City Engineer's Office.

Greymouth: M.O.W., Greymouth.

Invercargill: Invercargill City Corporation.

Napier: M.O.W., Napier (Mr T. Belshaw).

Palmerston North: P.N. City Council (Building inspectors' section).

Wanganui: City Engineer's Office.

Whangarei: Whangarei City Corporation (Building inspector).

PROCESS CONTROL, PRODUCTIVITY AND PROFIT

The symposium on "Process Control, Productivity, and Profit" at Victoria University in May unanimously passed the following resolution:

THAT symposium delegates generally agreed that:

- Automation is inevitable in New Zealand.
- It will be gradual enough for all sections of the economy to make adjustments without serious hardship, particularly if communication is maintained between employers, trade unions, technical training institutions and the Government.
- New Zealand will follow the more highly industrialised countries and learn from their mistakes.
- Full employment has generally been maintained since the war despite the automa:ion which has already taken place and despite the unfavourable terms of trade which, before the war, would have meant deep depression and unemployment. New Zealand is likely to remain a full-employment economy.

Automation has developed here first in the new large scale industries, e.g. pulp and paper, oil refining, steel, and now aluminium. These new industries have increased the number of skilled jobs available, and there has been no evidence of redundancy so widely feared overseas.

- The responsibility for retraining any workers displaced by machinery will fall first on the industries introducing new equipment, but in some cases it will become a public responsibility requiring all the usual co-operation of the Government educational institutions, employers and trade unions.
- The pace of automation in New Zealand will be largely governed by the amount of capital available, and it would be necessary for all sections of the community to increase savings and capital formation.
- The standard of living will rise as more mechanical aids are provided for each worker to increase his productivity.
- Increased productivity can be profitable to workers and employers alike, and to consumers, because automation will tend to hold costs and counter price inflation.

THAT A.C.I.S. and N.Z.I.M. be commended to further efforts *in* increasing the general understanding of technical means of raising the productivity and quality standards in New Zealand industry.

THAT consultation and co-operation be sought from the Government, tertiary educationalists, and the relevant industrial labour movement, in promoting the above objectives.

THAT, in establishing a Productivity Institute, the Government be asked to consider societies already working in that field.

The symposium was organised by Wellington societies, the Automatic Control and Instrumentation Society and the N.Z. Institute of Management and was attended by delegates from Australia and many parts of New Zealand.

NEW ZEALAND SCIENCE CONGRESS

The 12th New Zealand Science Congress will be held at Massey University, Palmerston North, from 31 January to 4 February 1972.

The Congress is being organised around the theme "The Cost of Growth", which the Manawatu Branch of the Royal Society, who are organising the Congress, consider a very relevant topic for New Zealand scientists to discuss at the present time.

The Congress organising committee is pursuing a policy which is aimed at communication between scientists and the public. It is hoped that a consequence of the Congress will be a reduction of the ever-increasing gulfs between the sciences, and between scientists and other groups in society.

To achieve the aims of the Congress, the papers will be presented under three groupings. An intra-disciplinary group will run on one afternoon and three mornings to provide a forum for scientists to hear papers of a fairly specialised nature. The inter-disciplinary sessions, containing papers presented for scientists of other disciplines, will cover three afternoon sessions. To encourage participation of the non-cientist, two evening Public Symposia will be held in Palmerston North City, to hear papers and discussion on "The Cost of Growth" and "The Cost of Stagnation".

The papers to be presented during the daytime sessions will be grouped under the following headings within the theme: (a) the growth and development of science in New Zealand, (b) growth and use of natural resources, and (c) growth and its impact on society.

About 80 scientific groups and bodies are currently on the mailing list of the organising committee but there may be some who wish to receive information and are not yet doing so. To rectify this, interested bodies should send their name and address to: Dr T. J. Brown, Secretary, 12th N.Z. Science Congress, C/- Public Relations Office, Massey University, Palmerston North.

PROFESSIONAL INTERVIEW MAY 1971

The following candidates were successful in the Professional Interviews conducted by The New Zealand Institution of Engineers in May, 1971

CIVIL

PASS: Allan, J. D.; Anderson, G. I.; Barber, N. E. A.; Bickers, A. N.; Booth, J. McK.; Bunting, **D. J.;** Camberis, D. A.; Campbell, P. L.; Carver, D. M.; Cato, R. E.; Cavanagh, T. N.; Clark, R. Baden; Cook, C. W. R.; Cutler, D. R.; Dunn, B. E.; Farley, P. J.; Fitzpatrick, J. C.; Flint, J. B.; Graham, J. D.; Grey, R. A.; Hegley, N. 1.; Jenks, J. R.; Jonstone, P. G.; Kennaird, A. R.; Langbein, I. W.; Lear, D. G.; Loughnan, A. A. M.; Matthewson, C. D.; Meek, W. C.; Muir, D. G.; Owen, M. C. R.; Raper, A. F.; Read, M. J.; Read, P. W. A.; Reynolds, P.; Rix-Trott, T.; Robinson, L. M.; Shepherd, B. O.; Selby, D. V.; Sligo, C. A. S.; Smirk, A. H. C.; Stotter, E. D.; Swain, P. R.; Tait, N. W.; Tweeddale, K. A.; Vivian, **R. J.;** Watkins, A. T.; Watts, **J. R.;** Sutton, N. W.

MECHANICAL GROUP

PASS: Allott, J.; Boughen, **D. R.;** Davie, G. E.; Day, E. B.; Firth, R. D.; Harrison, K. J.; Jones, A. L.; Mune, G. H.; North, C. L.; Still, G. A.

TELE-COMMUNICATIONS GROUP

PASS: Beech, A. L.; Brown, K. M.; Butel, D.; Chalmers, R. J.; Crimp, R. F.; Crumpton, R. E.; Diamond, J. R.; Dorrington, D. V.; Ducat, R. S.; Goodwin, R. I.; Lane, N. L.; Mansell, D. S.; Middleton, H. T.; Powell, B. G.; Pownall, M. J.; Ranchod, M.; Richards, J. V.; Roxborogh, W. J.; Saunders, A. M.; Woods, T. G.

ELECTRICAL GROUP

PASS: Beever, G. J.; Bull, D. J.; Dunkley, G. J. H.; Duxfield, F. R.; Hodder, D. W.; McIntosh, W. D.

TRAFFIC ENGINEERING

PASS: Clissold, C. M.; Palmer, M. R.; Toomath, **J. B.**

Candidates for Election

For Election as Members:

Baker, M. J.; Boughen, D. R.; Ducat, R. S.; Kampman, A. L.; Kennedy, **D. E.;** Palmer, M. R.; Strachan, R.; Toomath, **J. B.**

For Election as Associates:

Hall, W. C.; Long. G. E.

For Election as Graduates:

Beekhuis, W. J.; Cleary, G. L.; Duoba, S. V.; Feast, R. J.; Foote, J. L.; Lobb, G. B.; Marshall, G. S.; Nguyen, P. H.; Raba, T.; Sampson, R. A.; Taylor, C. R.; Watson, I. F.

For Election as Student:

Watson, L. J.

Graduates for promotion to Members:

Dunkley, G. J. H.; Fraser, I. A. N.; Holbrook, R. J.; Roxborogh, W. J.; Still, G. A.

Student for promotion to Graduate:

Taylor, W. A.

Changes in the Auckland university engineering degree courses

THE following changes in the degree courses at Auckland were brought to the attention of the Education Committee of the Instiution at a recent meeting.

1. B.E.

In the Third Professional Year of the Chemical and Materials Engineering degree, the two-paper subject Chemical and Materials Technology has been replaced by a one-paper subject Chemical Engineering design. The one-paper subject, Process Control, formerly an option, has now been made compulsory. Candidates still select two electives.

The Senate last year accepted the principle that a special school, such as Engineering, might introduce a teaching and examining schedule different from the traditional one. Faculty hopes to complete its proposals for a two-semestral year in the Professional stages of the B.E. degree and to present these to Senate for approval this year, to go into effect in 1972.

2. M.E.

The statute, which was rewritten for 1970, has been further modified. The new regulations will now permit candidates to take an M.E. either by passing three one-paper subjects and presenting a thesis having the weight of three papers, or by passing six subjects. In the latter case one or two of the subjects could take the form of a project.

3. M.Phil.

The university has introduced a completely new degree, the Master of Philosophy. This is intended for a candidate who wishes to proceed to a master's degree in a faculty other than that in which he qualified for his bachelor's degree. The requirements for the degree are those for the master's degree in the faculty in which he is enrolled for the M.Phil. The intention behind this set of regulations is to free up inter-faculty and inter-university transfer.

It could have a significant effect in engineering by attracting into master's programmes students from certain of the sciences. The faculty had already made some provision for this in making it possible for a B.Sc. to carry out a master's programme in engineering, but to be given the label M.Sc. The new M.Phil. has wider possibilities. For example, persons with a B.Tech. or B.Agr.Sc. from Massey could be readily admitted to an M.Phil. programme.

MODERN MANAGEMENT FOR ENGINEERS

The second management training course in the annual series being sponsored by the Institution took place in Victoria University of Wellington from 9 to 21 May this year. The reduction of government spending in this field reduced the numbers attending, unfortunately; the course had 13 members, as against the full number of 23 that attended in 1970. At the same time, there was a fair spread of engineering occupations represented by the course members, as the list below shows.

Course members, 1971

B. T. Anderson, Auckland City Council; T. E. Buchanan, Dunedin City Corporation; D. Davis, N.Z. Railways, Auckland, G. L. Dickson, Auckland City Council; V. Chung, Telecommunications engineer from Sabat, Malaysia, in New Zealand for training under the Colombo Plan; J. W. Jones, **B.P.** New Zealand Ltd.; A. McDonald, Downer & Co. Ltd.; 1. McDougall, Ministry of Works, Trentham; I. J. Mallett, N.Z. Post Office, Dunedin; P. J. North, Murray-North Partners, Rotorua; K. Wright, Shell Oil N.Z. Ltd., Auckland; K. A. Bloomfield, N.Z. Electricity Department, Wellington.

The course, small as it was, had the benefit of top-level teaching from the University. Professor B. P. Philpott spoke on general topics in economics, including the general economic environment and the functioning of the economy, allocation of capital in the economy, and evaluation of engineering projects at the level of the firm; Professor G. A. Vignaux, head of the Department of Information Science, spoke on mathematical concepts for decision-making; Professor F. Jackson gave an introduction to the analytical tools of the economist that can be applied to planning either by a firm or by a government department—cost behaviour, market structure, pricing policies, and so on. On personal relationships, Professor G. Fogelberg talked about the art of management, particularly using case studies; Mr. G. H. Hines made an examination of the factors which influence working relationships in the organisational environment, and studied the general question of interpersonal relationships; and there were two speakers from the Industrial Relations centre at the University—Mr. N. S. Woods and Mr E. J. Keating.

Altogether, they were two full weeks of study, which were thoroughly appreciated and enjoyed by those who took part. At the course evaluation, the final session of the course, the general feeling was put into words by one course member, who said what a pity it was that on this occasion there weren't more people able to take advantage of the opportunity to be present.

As in 1970, the Institution is indebted to the staff of the University Extension Department, in particular Mr W. C. Cook, for the organisation and running of the course.

Next years course is already being planned. When the Council originally decided to sponsor these courses, in 1969, it was agreed that they should be held in more than one centre—and it seems likely, at this stage, that next year's course will be in a centre other than Wellington. We hope to have something definite to report in a month or two.

Changes in the Roll of !Members

The following additions to and changes in the Roll of Members result from ecent decisions of the Council, subject to confirmation under the provisions of Rule 7.1 where applicable.

Members :

M. A. L. Fletcher, B.Sc.(Hons)(Elect.Engrg), Associate Member of I.E.E., P-O. Box 12085, Wellington North.
M. B. Foley, M.I.M.E., M.N.Z.I.D., 23 Pearsons Avenue, Hamilton.
M. R. F. Gale, B.E.(Civil), 33 Fourth Avenue, Tauranga.
M. W. J. Harrison, B.Sc.(Elect.Engrg)(Belfast), Associate Member of I.E.E., 4A Trelissick Crescent, Ngaio, Wellington 4.
M. Prof. R. F. Meyer, B.E.(Mech.), Ph.D.(Manchester), A.F.C.A.S.I., M.A.I.A.A., School of Engineering, University of Auckland, Private Bag, Auckland.
M. C. J. O'Halloran, B.E.(Civil), 9 Walker Road, Rotorua.
M. J. C. Stras, B.S.(Civil Engrg), M.S.(Civil Engrg), M.A.S.C.E., P.O. Box 3, Houston, Texas, 77001, U.S.
M. B. B. Turner, M.I.Gas E., 44 James Grove, Stokes Valley.
M. G. R. White, B.E.(Elect.), Associate Member of I.E.E., 46 Mary Huse Grove, via Trentham Camp P.O.
M. W. E. Wood, M.I.M.E., 363 Jackson Street, Petone.

Associates :

Assoc. A. S. Clement, 901A Sealey Street, Thames.
Assoc. A. E. Jones, 10 Queen's Parade, Devonport, Auckland 9.
Assoc. I. C. Levy, 14 Wainuiomata Road, Wainuiomata.

Graduates :

Grad. H S. Broome, B.E.(Elect.), 43 Waripori Street, Wellington 2.
Grad. P. Bryant, B.E.(Elect.), M.I.E.E.E., 89 Wallace Place, New Plymouth.
Grad. H. B. Dobson, B.E.(Civil), 334 Kamo Road, Whangarei.
Grad. G. W. Drayton, B.E.(Elect.), 113B Rockinghorse Road, Christchurch 7.
Grad. B. H. Knowles, B.E.(Ag.),, Leigh 18 Clart Road, Hamilton.
Grad. R. G. Nevill, B.E.(Elect.) Road, Matakana.

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General

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Cover picture

The Port of Tauranga—looking north.

NEW ZEALAND
Engineering

THE JOURNAL OF THE N.Z. INSTITUTION OF ENGINEERS Vol, 26, No. 7, July 1971

Jubilee History

THE jubilee history of the Institution* has now been issued. It is a wide-ranging and fascinating work that has taken its author, W. L. Newnham, eight years to compile. It is a record, not only of Institution activities, but also of engineering achievement in New Zealand that begins with the pick and shovel, steam engine, and spans a period of extraordinary progress.

The Institution was founded as the New Zealand Society of Civil Engineers on 10 June, 1914, with 85 corporate members. The horse was still the main beast of burden on the farm, and the steam engine was still king; but the motor car had first appeared on New Zealand roads in 1889, and was becoming a familiar sight.

The total electricity generated in the country was only 35,000 h.p., but the Aid to Water Power Act of 1910 had meant the beginning of the State-owned chain of hydro-electric power stations, and in October 1914 the first section of the Lake Coleridge scheme was opened.

The manual telephone exchange was in general use, but plans had already been made for automatic exchanges for the four main cities and for five other centres, including Blenheim and Palmerston North. The first wireless station for transmitting messages had been set up in the general post office in Wellington in 1911.

Flight was a strange concept, but only a year after the Wright Brothers made history, the first flight by a powered aircraft was made in New Zealand on 31 March 1904—a flight believed to be the second in the world.

Action in New Zealand in so many of these fields was halted by the war, but technological progress was accelerated, so that in the early post-war years a great many engineering projects moved ahead. The number of mechanical and electrical engineers increased, and there was pressure for a change in name for the Society. Civil engineering, as distinct from military engineering, had once been adequate as an all-embracing concept; but this no longer applied. An attempt to change the name in the late twenties was unsuccessful and the depression was to intervene before, in 1937, the New Zealand Society of Civil Engineers became The New Zealand Institution of Engineers, with the explicit purpose of providing a forum for engineers in all disciplines, and an organisation representative of their combined interests.

he coat of arms of the Institution was created in 1969, and it is the motto then adopted, "Learning, Service, Achievement", which gives W. L. Newnham's book its title.

It is impossible, in a single page, to list the multiplicity of topics covered in this volume. An engineer in any field will find something of interest to him and a mine of information.

It is a unique and imaginative record of engineering progress in New Zealand covering sixty-five years of this century. It is not only a story of technical achievement, it's a human story as well, with the personalities of the prominent engineers of these years and their individual achievements in the field, interwoven with the work of the Institution on behalf of science and profession of engineering in general.

Two people in particular were responsible for the publication. They are W. L. Newnham, who compiled and wrote it, and F. N. Stace, who edited and prepared it for publication.

As engineers and as citizens, we can justifiably feel proud of the work of these two men who, by their successful completion of this long and arduous task, have successfully added to their own already major contribution to engineering in this country.

*"Learning, Service, Achievement: Fifty Years of Engineering in New Zealand" by W. L. Newnham (edited by F. N. Stace), published by the N.Z.I.E.

Tauranga Harbour

Development work by the Ministry of Works at Mount Maunganui 1953-1966

B. W. SPOONER
B.E., C.ENG., F.I.C.E. (FELLOW)

R. A. SIMPSON
B.E., B.SC., C.ENG., M.I.C.E. (MEMBER)

J. H. FYSON
B.A.(CANTAB.), C.ENG., M.I.C.E. (MEMBER)

This paper sets ow the background of overall development policy leading to construction of new deep-water berthage at Mount Maunganui, Tauranga Harbour, by the Ministry of Works on behalf of the Tauranga Harbour Board. Particular problems whch arose in the planning and development are outlined, and a summary given of construction types and methods adopted.

B. W. SPOONER, ***chief civil*** *engineer, Ministry of Works, started his career with the Public Works Department on the Waitaki electricity scheme in 1934. In 1937 he was transferred to Hawke's Bay to work on the Waikaremoana hydro-electric development at Kaitawa and Piripawa and also on the East Coast railway between Napier and Wairoa. In 1947 he was appointed senior engineer in the power design office in Wellington, working initially on the large civil works involved in the establishment of the substations for the 220 kV distribution system.*

In 1955 he was appointed chief designing engineer and was concerned with the design of bridges for New Zealand's motorway system.

He was a member of the Council of N.Z.I.E. for a number of years, and served as an executive vice-president and, in 1968-69, as president.

1. INTRODUCTORY

BY 1950 some 560,000 acres of mainly exotic forest (principally pinus radiata) had been developed in the South Waikato, Rotorua, Taupo-Bay of Plenty areas, and N.Z. Forest Products and others at the southern end of these reserves and the Whakatane Board Mills at the northern end were already in production. The N.Z. Forest Service was actively investigating development of their Kaingaroa State Forest of 268,000 acres. Ministry of Works preliminary studies included surveys and probings in the harbour and entrance channels of Tauranga Harbour ready for development for forestry purposes. At this time the Whakatane Harbour Board claimed consideration for an alternative breakwater harbour inside Kohi Point. A Commission of Enquiry agreed with the departmental opinion that a Tauranga port would more satisfactorily serve the district generally and that annual charges for a Whakatane port would offset rail freight savings for forest products (Fig. 1).

The department estimated trade at Tauranga would reach one million tons in 25 years, including

This paper was first received 7 September 1970 and in revised form on 4 May 1971.

420,000 tons timber products, 210,000 tons primary produce, 180 000 tons fertiliser, 120,000 tons coal for industries, and 70,000 tons general goods and oil. The coal trade did not develop, being drawn from the Waikato, but, contrary to firm opinions expressed in 1950, the oil companies quickly adopted Tauranga as an import point; primary production is only now showing signs of major development but grain imports have become significant; development of timber products has been more rapid except in the case of sawn timber, while in the case of the quite unexpected trade in export logs growth has been high. Figures 2 and 3 show trade growth in relation to other New Zealand ports, and the nature of the goods handled at the port.

RALPH ANNA ND SIMPSON was born in Dunedin and is an investigating engineer on the staff of the Ministry of Works, while holding a separate appointment as marine works engineer, a technical adviser to the Marine Department and, through that department, to the New Zealand Ports Authority.

After five years on the engineering staff of the Otago Harbour Board and completion of the I.C.E. London examinations he went to Canterbury University College, taking degrees in civil engineering and science.

He was subsequently engaged on water supply construction and design with the Dunedin City Corporation (Deep Creek Scheme) for three years before resuming harbour work with the Napier Harbour Board as deputy chief engineer in 1937. At Napier his responsibilities were the supervision of dredging, construction of two new piers and breakwater extensions to restore facilities lost in the 1931 earthquake.

He joined the then Public Works Department in 1942 on marine works for the R.N.Z.N. and U.S. Navy in the Pacific.

As investigating engineer with the Ministry of Works he has been engaged on projects such as the initial stages of the aluminium smelter project, siting and services for the oil refinery, port and internal services for the Bay of Plenty forestry development investigations and mill siting for the steel industry, salt production and the introduction of Kapuni natural gas.

Other published works include "Otago Harbour" and "Napier Harbour Development".

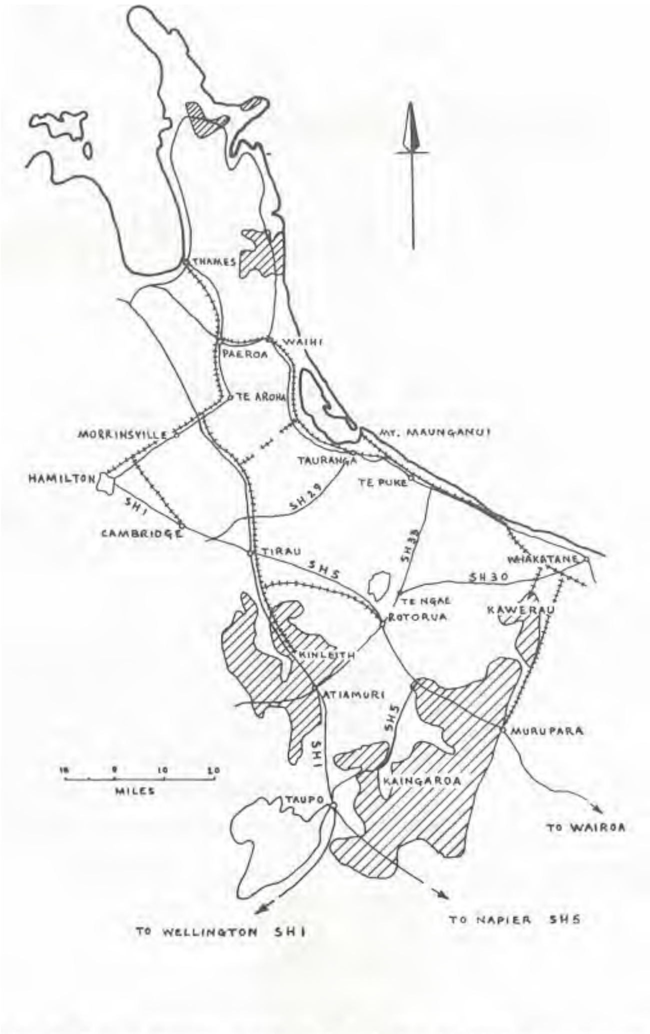

Fig. 1: Exotic forests, roads and railways in port contributing areas.

In 1952 the N.Z. Forest Service offered 23 million cubic feet of timber annually for 25 years, with two further extensions of 25 years, to be drawn mainly from the Kaingaroa Forest, for the purposes of an integrated sawn timber, pulp and newsprint mill, resulting in the formation of the Tasman Pulp and Paper Co. (with an initial Government interest of 51%). The Government undertook to provide power, housing, rail connection to the port and an overseas port at Mount Maunganui, about 90 miles from the plant site. Three 400 ft berths for inter-colonial vessels of up to 24 ft draught were required. In April 1953 the Cabinet approved development works in connection with the industry of just over $26.5 million, including $10 million for housing, $8 million for railways, $5 million for forestry works, and just under $2 million for port works and land. It was not desired that the port come under Government control, and agreement was reached with the Tauranga Harbour Board for the purchase of assets and for the operation of the port.

2. PORT DEVELOPMENT : WHARFSIDE

The work originally comprised 1,230 ft of berthage, rail and other services, storage sheds to suit Tasman requirements, navigation aids, land and offices. The success, timing, and rate of the forestry development being uncertain, an establishment period was allowed for, all expenditures and interest at current rates being funded against the Board for repayment. The first berth came into operation in 1956, by which time five oil companies, two flour mills and a co-operative fertiliser company were advancing plans for establishment of their industries at Mount Maunganui. A short extension of 175 ft was agreed upon in 1957 to provide one longer berth for these import trades in addition to Tasman exports. The Board was required to repay on short term and raise loan finance in the same manner as other harbour boards and to include rating security.

By the end of 1959 trade had advanced from 56,000 tons at commencement of construction to 570,000 tons/year, and an unexpected trade in export logs to Japan had reached significant proportions. The Board having earlier appointed administrative and pilot staff, also appointed in this year E. C. L. Otway as engineer to the Board. In the event that the department was to continue berthage extensions for a further extended period the taking over by the Board's engineer of rail and shed planning and development in rear of the wharf; the control of model studies for depth improvement in the entrance as earlier advocated by the department; and the day-to-day maintenance and management of port affairs greatly facilitated the task of wharf construction. The authors would like to record the extremely harmonious relationship which existed between two engineering organisations on the one site both consulted by the same Board. Mr Otway's forbearance, as well as his help during what might be termed a joint consultantship, over the period 1959-66 is gratefully acknowledged.

The log trade changed the shipping situation markedly. Japanese vessels, shut out of Russian Pacific ports in the northern winter, arrived at Tauranga in such numbers that up to 14 of these vessels were lying off Tauranga at times awaiting berthage and maintaining the principle of first arrival-first berthage—to the detriment of other shipping operations, including Tasman, for which the Government had considerable responsibility. There was need to regulate the use of berthage, the standard of vessels loading, and the operations of innumerable logging

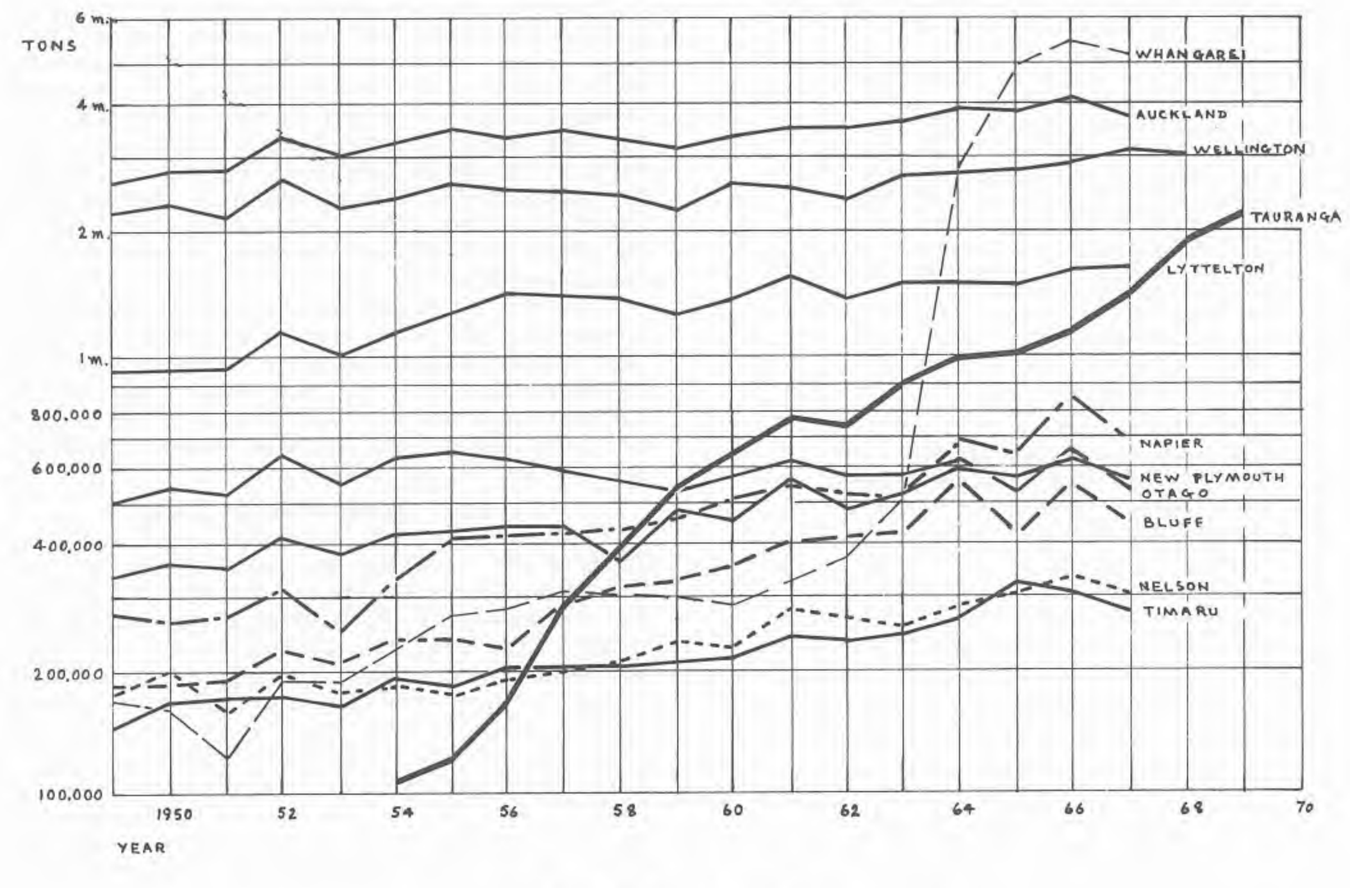

Fig. 2: N.Z. ports' annual cargo tonnages.

promoters, haulers, and log purchasers. A new agreement and legislation was enacted whereby the Board obtained borrowing powers and a right of rate (not exercised) while shipping and storage priorities were made subject to decision by the Board during construction of 1,200 ft of further berthage, plus a tanker berth. Tasman assisted with a short-term loan and was granted prior rights for 1,000 ft of berthage and for open storage in rear of that berthage for 20 years, but with the right of the Board to re-establish the company elsewhere and to compensate the company only for the residual value of fixed assets on expiry of the term. Rights for 600 ft of berthage only were to be granted to Tasman until the Ministry of Works completed the extensions.

JOHN HUGH FYSON joined the Ministry of Works in 1956 and became chief construction engineer (civil) in 1969. He was born in Lowick, Lancashire, and received his basic training at the school of Military Engineering, Chatham, Kent. He served with the Royal Engineers between 1935 and 1955, in France, Belgium, Tunisia, Holland, Germany and Burma. He

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independence in Burma. He was in civil engineering with Balfour Beatty and Co. and Sir Alexander Gibb and Partners while in the army.

In New Zealand he was at the Gisborne M.O.W. residency from 1956 to 1958 and this was followed by a year on Rongotai aerodrome construction. BP tween 1959 and 1961 he was with the head office, Aerodromes Branch, and then joined the civil design branch in 1961 before assuming his present appointment in 1969.

He was a member of the N.Z.I.E. Examinations Committee between 1963 and 1969. He is a member N.Z. National Committee for International Hydrological Decade (a UNESCO project) and in 1970 spent two months leave in Europe (including a trip by train across Russia). While en route, he attended the Geneva meeting of I.H.D. as N.Z. representative.

He has published papers on "Earthworks for Rongotai Aerodrome" and "Aerodrome Pavement Design" in N.Z. Engineering.

By 1961 cargoes reached 730,000 tons/year with an intensity of 328 tons of dry cargoes per lineal foot and a total intensity including oil of 460 tons/lineal foot of available berthage. The dolphin berth was replaced by 600 ft of complete berthage, and two further extensions brought the total berthage construction by the Ministry of Works to 4,200 lineal feet. This work was mainly complete in 1966, although dredging and some minor works carried forward for further periods. Powers to control shipping remained in force until 1966, with the port trade then standing at 1.4 million tons per year.

One storage shed for Tasman 285 ft X 100 ft and a second general cargo shed of similar construction of 100 ft length were provided in the first stage of construction. Tasman, at this early stage, proposed a rail-wagon loading bank within the rear of the shed with overhead travelling cranes and transfer to shipside at wharf level. This was accommodated by crossfall rear to front of shed which was ideal for floor drainage but later gave difficulty in end-on-end vertical stacking of newsprint rolls. To save time, tenders were called for design, supply and erection of these sheds and a smaller sawn timber storage shed to a service specification. There were many problems in design checks and adjustments to tenders and the authors would not willingly adopt such a method again. Tasman later built new wharfside storage with level floor at ground level for fork-lift operation. The first 1,230 ft was planned as a single three-berth entity for railways delivery of Tasman cargoes with rakes of trucks withdrawn at meal breaks. New Zealand Railways and the shipping company gave this operation much careful study before deciding on two-track loading to ships with a rear assembly track. This was not well suited to general cargo operations, which could not be closely timetabled, and this also proved the case later for Tasman vessels as their shipping orders diversified. These berths were later used as log berths and trackwork elsewhere reverted to more conventional layout.

In 1963 a Commission of Enquiry recommended a National Roads Board programme of radial and ring road improvements estimated at $6 million over the following four years, and the construction of the Kaimai railway deviation with closure of the existing east coast railway from Apata to Paeroa to facilitate access to the Bay of Plenty.

3. PORT DEVELOPMENT: LAND

Land was taken at Mount Maunganui under the Public Works Act during the construction of the East Coast Main Trunk Railway and the right of way from the rail junction at Te Maunga to the Mount was retained, plus 156 acres adjacent to the waterfront and running back up the rail access route to the main highway. Disposal of this land had been resisted because of its probable value when the Kaingaroa forest reached the development stage. In 1953 approval was obtained for the acquisition. under the Public Works Act, of a further 146 acres for better utilisation. This total area of 302 acres was zoned for industrial and harbour purposes, and roading and services established as demand arose. A total of 247 acres was available after deductions for roading. In

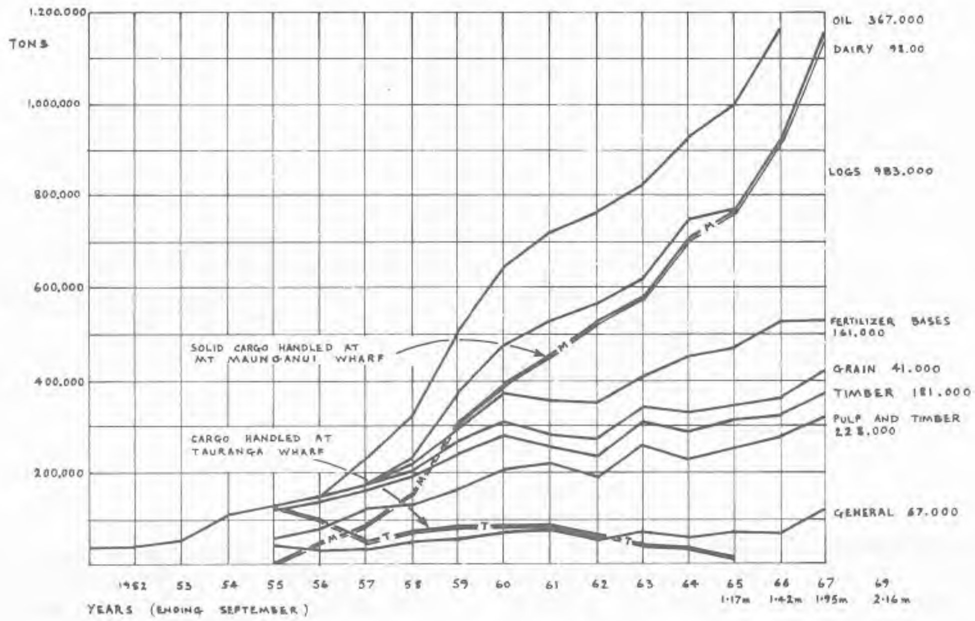

Fig. 3: Port of Tauranga cargo statistics.

conformity with arrangements already made with the Tauranga Harbour Board, 44 acres adjacent to the original waterfront was sold to the Board. A separate 71 acres of reclamation between the original waterfront and the rear of the wharf using dredgings from berths and swinging basins also formed part of the construction works vesting in the Board.

The line of continuous wharf face was set as a balance of several functions: To provide, with dredging, approximately the waterway existing before construction; to provide adequate swinging room for vessels; and to allow a good depth of land in rear of all berths. In the event, it was found possible to provide (excluding the wharf width of approximately 45 ft) a land depth of 480 to 600 ft for the Board's purposes, while making sufficient provision for railway marshalling yards and station, and for light industrial land shoreward of this port operations area. Rail services were provided and the land is now practically all taken up, either by lease or purchase from the Crown. Land for noxious industry, including oil tankage ard the fertiliser works, was located as far south as possible.

Again, reference should be made to problems which arose in connection with land development. A service road, 66 ft in width, in rear of the cargo sheds was provided and the Board and others pressed for long-term leases in rear of the access roadway. The department reluctantly had to accept the position but the Board shortly thereafter came to recognise the importance of the full depth of land being retained for harbour purposes. Legal access had then to be provided to the flour mills by a 40 ft unformed Government road, with actual access in an agreement between the Board and the parties for use of the formed service road. Other areas having been tentatively allocated by the Board, the lessees were given to understand that occupation was at the pleasure of the Board only, and to consolidate the position the Crown land and reclamation was transferred to the Board by legislation under the Reserves and Other Lands Disposal Act 1965 subject to the right of the Board to terminate any tenancy or lease on 28 days' notice and without compensation, the renewable, leases to the flour mills and the balance of lease to the Tasman Pulp and Paper Co. only excepted. A renewable lease was later negotiated between the Auckland Cold Storage Co. and the Board and special legislation was passed in 1967 to permit long-term leases for a total of nine acres in two stages. The Board was placed in a good bargaining position with the company by the need for supporting legislation.

Considering a berthage length of 500 to 550 ft and land depths of 500 ft and upwards, storage space was generally about 51 acres per berth. With the advent of the log trade, even berths with some 71 acres of storage space in the rear proved insufficient, it requiring up to 1½ times this area to serve a log ship of the order of 25 ft draught (2 million Japanese Hakendaal feet or 5,300 tons) with reasonable time for assembly of cargoes. Greater draught of log vessels could accentuate this problem. A more liberal provision of operating space than generally provided at New Zealand ports has proved sufficient only because other cargoes have been much less demanding in storage space.

Figure 4 shows the port-side development totalling 373 acres.

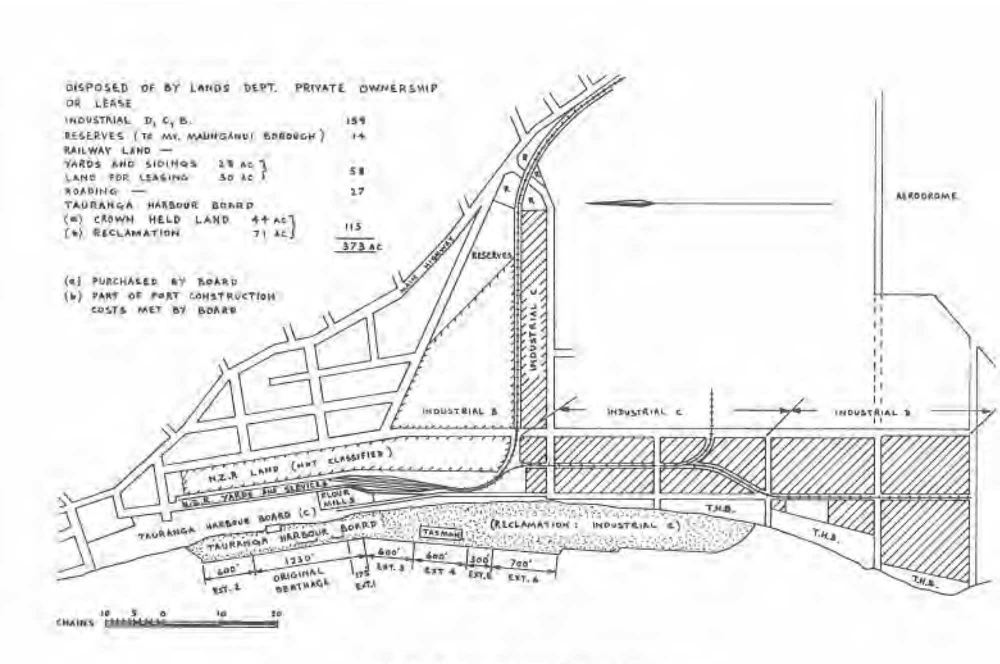

Fig. 4: Portside land development.

4. DEVELOPMENT : WATER SPACE

During 1950-1951 the department investigated the area of berthage and swinging room and a 350 ft long bar area in the port approaches carrying 22-23 ft depth at low water. Readily dredgable sands to well below development levels were found with no indication of harder strata. The initial dredging work for the first berths was done by the Westport suction dredge *Eileen Ward,* and, before departure, a cut was made at the outer shoal of about 30,000 yd, but a survey some six weeks later showed no apparent benefit. On construction at Mount Maunganui being committed in 1953, the department pressed the Board to initiate model studies, it being considered that a mole extending seawards from Matakana Island to direct the ebb should improve entrance depths. It was not until the appointment of the Board's engineer that support was secured for this work. Having been commenced late, and taking longer to process, at the Hydraulics Research Station at Wallingford than anticipated, support rather than guidance was given to decisions on wharf alignment, and possibly because of the infirm bedding of the pumice sands in the entrance and estuary their conclusions on channel development problems were conservative. The Board is meeting with considerable success in entrance dredging without incurring the heavy capital cost of training works, and with elimination of a major bend approaching the wharves by dredging the Cutter channel the Board has lifted the limiting draught from 23 ft to 281 ft and now contemplates additional improvement.

5. LAND RECLAMATION

Department of Scientific and Industrial Research laboratory tests on harbour bed sands showed an angle of repose in water of 30°, a critical density of about 83 lb/ft^3, a fairly uniform grain size with a median of about 0.04 in., and considerable difficulty in achieving compacted densities (dry) of 98 to 104 lb/ft3.

The low compacted densities were due to the limited grading range, the rough angular form of the grains, and void inclusions in these pumice sands. The non-availability of suction dredging plant led to harbour dredging and side slope formation for the first wharf section being done by the Westport dredge, which could not pump ashore, and first land reclamation using dune sands. In these sands the grains were more rounded but on investigation showed similar physical characteristics except that the critical density was as high as 95 lb/ft^3. It was most difficult to achieve satisfactory in-place densities with these sands when compacted in the dry with tractor and carryall in 8 in. layers, and in water by blading down in similar layers on a flat slope from above water line. Test compactions on 15 in. and 30 in. loaded plates, including operating heavy machinery close alongside and with a surround of light explosive charges had little effect. Short of vibroflotation, it seemed that densities of 98 to 104 lb/ft^3 must be accepted. Loaded plate tests indicated shear resistances in excess of 20,000 lb /ft2.

Following an excess displacement of the first few hundred feet of the wharf to be referred to later, Reynolds penetrometer tests of sands gave some extraordinarily high penetrations, one as high as 37 in. in one blow (140 lb drop 30 in. on a pipe 2 in. o.d. and many of the order of 10 to 15 in. per blow in front of the wharf. These loose conditions could not be reproduced in the laboratory and either some mechanical bonding had been destroyed in sampling, or the samples were taken from areas of predisturbed ground in the way of shipping movements or construction. Sampling by the same methods for later wharf extensions disclosed no such loose compactions at any site.

The greater part of later reclamation was done using a small suction dredge improving depths off the wharf face at the same time. In situ reclamation fill remained generally of a dry density of little better than 100 lb/ft^3 with hydraulic fill methods although some densities up to 108 to 110 lb/ft^3 were recorded.

6. WHARF DESIGN

Three designs were considered for the first 1,230 ft of berthage—circular cells of steel-sheet piling interlinked front and rear, concrete piles and deck with rock mound retaining wall, and concrete piles and deck with steel sheet pile retaining wall partially reinforced by a rock mound. The first was abandoned as shearing forces in clutches were fairly high with the class of fill and foundation materials available, the second on estimated costs of rock fill at $3 per ton, and the third adopted (Fig. 5). Design allowed for Coopers E loading on the wharf and track in the rear and for uniform loading of 6 cwt/ft^2 on the deck distributed to give maximum stress conditions. Portal crane loads, maximum leg load being 35 tons on two wheels spaced 7 ft, were also allowed for.

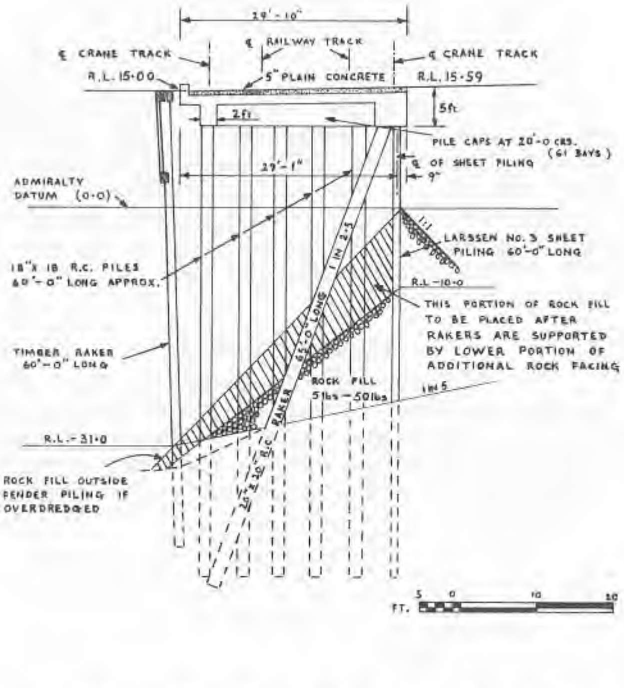

Fig. 5: Typical wharf section—initial 1,230 ft berthage.

Because of problems in dealing with sands of fairly uniform grain size, the wharf was conservatively designed for sands of an angle of repose both wet and dry of 25°, a density of 120 lb/ ^{3}, a water retention level of three feet higher than on the tidal face, and with stable ground assumed to exist 10 ft below the dredged level of 31 ft below low water. The vertical pile loading was 47 tons/pile under maximum conditions, and four rakers per 20 ft bay were provided sufficient to develop 0.03 to 0.04 g against earthquake.

Piles were jetted to 3 ft of final level and then driven to a total penetration of 20 ft. One hundred piles had been driven before lead ingots could be brought from Auckland for testing, when a selected pile of short-driven penetration and total penetration of 18 ft yielded at 71 tons. This was lower than expected, but redriving tests on piles failed to develop any large set until after 10 or more blows. The driving penetration was made a minimum of 5 ft, the minimum penetration 20 ft and retest driving was made at intervals on selected piles of poor driving conditions. Later tests also on half-size piles tended to indicate that not more than half the total bearing was developed by the side faces of the pile. Fender piles spaced at three per bay with top and bottom walings were provided.

Deflection from reclamation loads of the order of 1¼ in. occurred as expected, but caused difficulty in the binding of expansion joint tongues (400 ft spacing). Following consecutive firing of single plugs of gelignite at three levels close to each fender pile along the first 500 ft of the work, in an attempt to inhibit toredo growth in fender timbers, forward deflection was found to have increased to a total of 2¾ in. Some shortage of penetration owing to overdredging was found at points, there was some evidence of propeller scour at the berth and over 4 in. of rain fell during the previous night and up to the discovery of movement in the early afternoon. There is no doubt, however, that the firing of the explosive charges triggered the movement. Tie-back strengthening was therefore inserted in this first design. This comprised a continuous anchor wall of sheet piling of 10 ft total depth with a continuous waling set 180 ft in rear of the wharf inner face. Two tie-backs per bay, each consisting of 12/0.276 in2 post-tensioned cables capable of being stressed to 140,000 lb/in^2, were led through 2 in. polythene tubing and grouted up after tensioning. This provided up to 90 tons pull per bay, but the full load was not mobilised where the excess forward movement had been recovered with a lesser pull.

The next short extension of 175 ft to the south followed the same deck pattern but the deck was widened and a full mound provided with omission of the steel sheet piling. As the price of rock fill by now was down to $1.25, this was not only a more satisfactory design solution but in spite of the additional vertical piles was considered to be more economic. The principal problem here was a section of hard driving not encountered elsewhere in the work and difficulties in the first stages among the rock fill of the original wharf and its approach mound from shore. In all

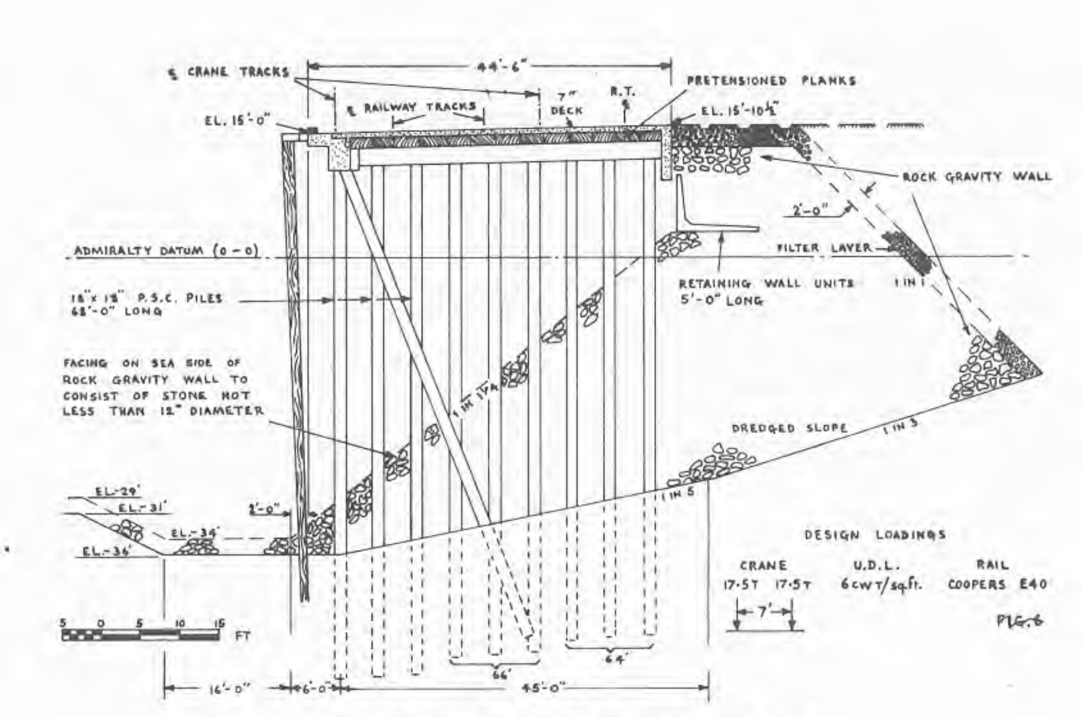

Fig. 6: Typical wharf section—extensions 3 to 6.

future extensions additional bents of piles were driven for the next extension beyond the rock fill so that this problem did not arise. To reduce the breaking down of pile heads a special cast steel driving cap was used through which the cap imbedment lengths of the pile rods protruded and then were led clear of the hammer stroke. With adoption of precast slab construction, this method of driving was later used only for raker piles.

In succeeding extensions, further modifications were adopted with the tying in of vertical pile heads by a deep imbedment in a cast *in situ* cap without breaking out the pile reinforcement, and the placing of precast, prestressed deck planks to span between caps. The rock mound being adequate for fill retention, two raker piles only per bay were provided, anchored to the seaward beam and principally intended to absorb bollard pull and berthing loads (Fig. 6). Owing largely to these successive design modifications and to the expertise developed during a fairly continuous construction programme over the period 1953 to 1966, costs of the last sections of the work were held very closely to original costs in spite of rising costs in the construction industry.

Costs (Table I) are best expressed as cost per lineal foot of berthage. This includes dredging in front of the berth and depositing,in reclamation in the rear, fendering, rail tracks and all wharf services, but excluding sheds and other works in rear of the wharf.

TABLE I

Wharf	*Length* (ft)	*Cost*	*Cost/* lin. ft	
Original plus 175 extension.	1,405	$2,162,000	$1,540	Construction 1954/1958
Extensions 2 and 3	1,200	$1,512,000	$1,260	
Extension 4	600	$844,000	$1,406	
Extension 5	300	$426,000	$1,420	
Extension 6	700	$940,000	$1,341	Completed 1966/1967
Total	4,200	$5,884,000	$1,401	

Expenditures by the Ministry of Works, including wharf construction, sundry other works related to shipping services, and land acquisition and development totalled $7.4 million. The department spent a further $16.4 million on housing, roading and railway extensions over the 1952/58 period for the forestry department, and considerable sums later, particularly on roading improvement.

7. ACKNOWLEDGMENTS

The authors would like to record the excellent cooperation between the department and the harbour board at all levels, and to thank the Board's chairman, K. S. Calder, and the then Commissioner of Works, F. R. Askin, for permission to publish this paper.

* * * * * *

Italy's production of *sintered titanium*

G. COPPA-ZUCCARI

Titanium was discovered in 1791 but extraction difficulties postponed its use as a metal for many years and limited its applications to the production of white pigments from rutile. Its feaures (Table 1) interest the aircraft and missile industries, resistance to chemical aggression attracts the chemical industries, and, at weight parity, it is the strongest of all metals.

Giovanni Coppa-Zuccari was *born in Rome and attended the Liceo Scientifico (Roma) Secondary School, which specialised in scientific studies. He graduated as an industrial engineer at the University of Rome, attaining a qualification which enabled him to exercise the profession of road engineering and then won a competition as assistant to the chair of applied chemistry in the Universities.*

He began his career as design engineer with a petrochemical company before becoming a technical journalist, a specialist in the association of foreign press in Italy (Associazione della Stampa Estera in Italia) in 1940

For about the last 10 years he has been a consultant for industrial matters with Italdesign Co. (Italian consulting engineers) and three years ago was in Zambia for three months for this company.

Immediately after the war he became chief editor of the Enciclipodia Italiana *for industrial topics.*

He is a member of the Sindasato Italiano Ingegneri and as a specialist technical author has many publications to his credit. He has established a technical documentation Service in Italy.

This paper was received 17 August 1970 and has been rephrased in parts.

TABLE I

Properties of titanium

Specific weight: 4.50 g/km^3 (i.e. between aluminium 2.70 and steel 7.80).
Melting point: 1680°C.
Boiling point: 3000°C.
Tensile breaking point: 58 kg/mm^2 (similar to semi-hardened 0.4% carbon steel).
Resistance to fatigue: Very high.
Resists nitric, sulphuric and hydrochloric acids.
Only hydrofluoric acid attacks it.
Resists corrosion in a normal atmosphere up to 300°C.

I. EXTRACTION OF TITANIUM

IN 1937, W. Knoll, of Luxemburg, patented a process by which titanium tetrachloride was reduced with magnesium to yield metallic titanium in porous form (sponge). The process is very costly and the sponge must be transformed into semi-processed metal at considerable additional expense.

Powder metallurgy or metallo-ceramics is a technology based on sintering by means of the compression of metal powders at temperatures below their melting point. This technique permits the addition of metals incompatible in the molten state or the addition of non-metallics such as graphite or synthtic resins, thus improving quality while simplifying production and reducing production costs. By using powder metallurgy it is possible to avoid diffifficult processing conditions associated with titanium's high melting point and its reactivity to hydrogen at this temperature.

A titanium mineral (rutile or enriched ilmenite) is combined with chlorine at very high temperature and yields impure gaseous titanium tetrachloride which is purified. The resulting product is reduced with sodium or magnesium, in a kiln, yielding impure metallic titanium (titanium sponge) together with sodium chloride or magnesium chloride. Then the latter are processed in an electrolytic bath where chlorine and sodium or magnesium are recovered while titanium sponge is subjected to a refining process. After that, the pure titanium is either melted and utilised for production of semi-finished pieces or is crushed. The resulting powder is sintered and used for diecasting.

TABLE II	
Natural sources of titanium	
Rutile (tetragonal)	TiO_2
Anatase (octahedral)	TiO_2
Brookite (rhombic)	TiO_2
Ilmenite (ferrens titanate)	Fe TiO_3

Today most processes are modified and improved forms of Knoll's method using magnesium to reduce the tetrachloride, although sodium is now becoming a common reducing agent. Nowadays, fluild-bed equipment is normally used for preparation of tetrachloride and rutile is preferred as raw material. The reserves of this mineral are limited and a shortage can be expected; its price has reached about 1000,000 lire (US$170.00) per ton and is tending to rise.

In Japan (at Osaka), enriched titanium slag is obtained by processing with coal in an electric furnace. This yields slag which contains up to 94% of TiO_2, including some in the form TiO_3 which can be chlorinated even more easily than rutile, while the iron, calcium and magnesium content are reduced to a minimum. The processing is done in open electric furnaces of modest dimensions (1500 kW). From 1800 kg of ilmenite ($FeTiO_3$) with 37% of TiO_2, and 280 kg of petroleum coke is a yield of 1000 kg of slag and 500 kg of poor quality pig-iron which can be refined. The energy requirement is 3700 kWh per ton of slag. If the value of the pig-iron is deducted the cost of this slag totals about 80 lire/kg (US$0.60 lb).

The Canadian Sorel slag and the slag obtained in Italy in the past are not very suitable for chlorinating owing to their low titanium content (65% or 70% of TiO_2) and high calcium and magnesium content.

Recently, a new process for extraction of TiO_2 from ilmenite has been developed, based on the reduction of iron oxide to metal and its subsequent elimination by means of chemicals. The process seems promising, but the titanium dioxide thus obtained is a fine powder and this complicates the chlorination process.

The quality of the metal obtained depends on the purification of tetrachloride, and this is a problem that has not been satisfactorily solved, either technically or economically. It is carried out by distillation, which is preceded by processing with reducing reagents and/or with precipitants such as derivatives of petroleum, copper dust, or sulphuric acid. These reduce the salts of impurities with lower valency (which are more easily separated by means of fractional distillation) or precipitate them in form of slush which can be separated mechanically. Sulphuric acid is the most efficient and least costly.

Reduction of tetrachloride with magnesium is carried out in a non-continuous manner because every attempt to carry it out in a continuous manner has failed. Nevertheless, considerable progress has been achieved as regards the structure and the size of the reactors used and this has led to lower production costs and improved product quality.

If the dimensions of the reactor are increased, the purity of the metal is improved because the surface/volume ratio of the lump of sponge is reduced. Many detrimental impurities such as oxygen, carbon, or nitrogen, concentrate on the periphery of the lump.

At present, two-ton, and bigger, reactors are used and, in all probability, their capacity could be increased while improving the method of extracting magnesium chloride produced by the reaction and introducing magnesium continuously. Then the dimensions of the reactor would be only a little greater than the lump of sponge obtainable.

2. EASIER PURIFICATION OF SPONGE

In a process developed at Montecatini-Edison the magnesium chloride is removed continuously and nearly wholly as the sponge is formed. This makes it easier to purify the sponge rapidly and fully during subsequent distillation, in accordance with Italian Patents 524,889 and 591,843, which are quoted below in a broad outline.

The first patent concerns an improvement in the reduction of tetrachloride of titanium with metallic magnesium, in accordance with the following equation

Metallic titanium is produced in a spongy form. Instead of magnesium, it is possible to use, as reducers, alkali or alkali-ferrous metals. However, the choice lies among magnesium, sodium, sodium-potassium alloys or a mixture of these on economic grounds.

This reduction must be carried out in a vacuum or in an inert atmosphere of a noble gas which is kept at a pressure slightly higher than the atmospheric pressure to prevent air from entering the apparatus. Titanium reacts easily, even at comparatively low temperatures, both with oxygen and nitrogen and even small quantities of the latter would make the metal useless. This reduction is carried out with a strongly exothermic reaction and it must be conducted at temperatures between the melting and boiling points at operational pressures of the reducing metals (or of a mixture of chlorides of reducing metals). In practice it is not possible to go above 950°C as the apparatus is made of iron and the interpenetration of iron and titanium is considerable even at such temperatures, while at 1000°C the two metals react violently.

Reaction is carried out in an externally-heated iron reactor. Reducing metal (magnesium in ingots, for instance) is dropped into this reactor, cold, then the reactor is closed hermetically by a lid, through which vacuum inert gas and $TiCl_4$ pipes pass. A vacuum is produced to eliminate air and the reactor is then filled with a noble gas (argon, for instance) and heated to 750 or 800°C; at this point, $TiCl_4$ is added gradually to avoid overheating. The formation of titanium sponge begins on the surface of the molten reducing metal while the chloride of reducing metal is deposited on the bottom of the reactor (from where it is collected periodically through a cock). The reducing metal ascends, by capillary attraction, through the sponge, which continues to swell. The reaction cannot be regular because, after a period of priming, the speed of reaction reaches a maximum (which must be moderated by reducing the admission of $TiCl_4$ and then diminishes progressively until the reaction practically stops. At this point, some 20% or 25% of the magnesium which has not been able to react remains in the sponge. After cooling the reactor, the Ti sponge formed inside it is taken out by a large cutter working inside the mass of the sponge, leaving a thick layer of sponge on the walls of the reactor. This layer is contaminated by iron but protects the product during the subsequent operations.

Opening the reactor and mechanical elimination of the sponge formed must be carried out in an air-conditioned environment, at a very low humidity, to prevent the hyproscopic chlorides which permeate the sponge from absorbing the moisture in the atmosphere. This moisture would increase oxygen content of the metal during the subsequent purification operations and cause deterioration and increased production cost.

Another method uses a reactor of the type described above with a plate metal container inside; the bottom of this container, with large apertures, just touches the level of the molten metal. Metallic sponge is formed and in this container is removed from the reactor by removing the container. This apparatus eliminates recourse to cutters, but involves the same disadvantages as the other method: the difficulty of controlling the reaction, the necessity for frequent and irksome removal of chloride formed with the consequent enormous losses of noble gases, the necessity to utilise a considerable surplus of reducing metal (which, in the case of magnesium, reaches 20% or even 25% of stoichiometric quantity), and the danger of the pollution of the sponge by the walls of the reactor. Because of the latter the sponge must be sorted subsequently.

3. CONTINUOUS REDUCTION

To reduce these difficulties, Italian Patent No. 524889 suggests feeding the reactor with alternating portions of reducing metal and tetrachloride which is to be reduced; by this process the chloride of the reducing metal is separated from the sponge as it is formed. This is arranged by causing the reaction in a container inside the reactor; this container has small lateral holes, a solid bottom and wholly or partly open top. Reducing metal and the tetrachloride to be reduced are introduced alternatively into this container.

If the holes are suitably sized only the chloride formed during the reaction will pass through them whilst the molten reducing metal is retained. Thus, the chloride is separated from the sponge as soon as it is formed and either collected in another receptacle also in the reactor or arranged to come out of the reactor in a continuous manner.

The initial quantities of reducing metal fed into the receptacle must be limited to reduce the hydrostatic pressure which the column of molten metal exerts upon the lateral walls of the receptacle. This eliminates the danger of molten metal coming out through the holes. For the same reason the lateral holes of the receptacle begin at the height of 2 in. or 1 in. from the bottom of the receptacle so the block of sponge is isolated from the bottom by a thin layer of chloride of reducing metal. In the case of an iron receptacle, this has the advantage that the block of sponge can be taken out of the bottom of the receptacle without damaging it.

It would be advantageous to combine the conception of a reactor with holes in its walls, with a reactor whose bottom has holes (Patent No. 591843). In such a basket-type reactor to form titanium sponge there are laterial holes which let out $MgCl_2$ as it is formed, at the same time a reaction takes place with metallic magnesium placed below the basket inside the main container, $TiCl_4$ is fed gradually while the reaction proceeds. It is possible to use simple magnesium ingots of high commercial purity instead of superpure magnesium. The sponge obtained is so porous that even a large block of it can be purified by distilling it whole instead of processing previously crushed sponge obtained by other methods.

The final purification of the sponge is still effected by means of vacuum distillation at about 950°C. In fact, all attempts to purify sponge by means of acid washing in aqueous or non-aqueous solvents have failed. Magnesium and magnesium chloride recovered by distillation are recycled.

About 1950, American and British plants produced titanium by reduction with sodium, but the quality was so poor that production was stopped. Later, the British plant resumed activities to turn out a better product. Recently, the American plant resumed production, utilising a substantially different process whereby, in a continuously-fed reactor, stoichiometric quantities of sodium and tetrachloride are made to react to produce titanium biochloride and sodium chloride which melts at a comparatively low temperature. The mixture obtained is loaded with an additional quantity of liquid sodium (sufficient to reduce the biochloride completely) in other non-continuous but capacious reactors. The mixture is heated to 950°C to complete the reaction and the mass obtained is then subjected to normal processing.

It is said that the process based on sodium is more economical than the one based on magnesium, but they are equivalent, except that the magnesium-based process yields a sponge of slightly superior quality which is easier to compact and turn into ingots.

4. SINTERING AND TITANIUM POWDERS

In the field of reduction fractioned into two stages, Montecatini-Edison have developed an experimental process which permits 80% of sponge to be obtained in powder form with high average purity whose features make it particularly suitable for sintering. This makes it possible to produce titanium powders even in small plants at comparative costs compared with the powders available at present.

Preparation of powders from sponge is a delicate and costly operation owing to the high reactivity of the powders and to the pollution to which they are subjected during crushing. Other methods (such as electrolysis or crushing and decomposition of titanium hydride in vacuum) are not only costly but generally yield powders with a rather high hardness.

The purity of the powders obtainable with Montecatini-Edison process remains at a high level in all granulometric fractions obtainable from 500 to 50 microns JO; foreign metals present in the fractions do not exceed 0.1% while hardness does not exceed, even in the finest fractions, 150-160 kgmm2 (Brinnell's scale).

The particular feature, that makes these powders particularly suitable for sintering is, undoubtedly, their dendritic crystalline form; in fact, every granule constitutes a microcrystalline agglomerate which can be easily deformed by compression and, thus, forced to penetrate deeply into the adjacent granules. Fine powders with particles of irregular shape can be sintered more rapidly and at a lower temperature than is required for compact spherical particles.

The above-mentioned powders can be used for sintered alloys with advantage because of the good homogenious and uniform distribution of additives which can be reached in metallic powders with particles ranging from 50 to 150µ.

This sintering technique offers interesting possibilities for the production of various parts (connecting rods, bushes, rings) as it permits the production of parts with features comparable to those of forged pieces. Likewise, it opens interesting prospects for rolling processes.

Italian Patent No. 802,736 covers a process invented by Montecatini-Edison for sintering titanium powders mixed polytetrafluoroethylene (p.t.f.e.) and obtaining products of p.t.f.e. loaded with titanium.

When processing p.t.f.e. and similar resins by die-casting or extrusion technique, it is necessary to take into account the fact that their powders soften at about 300°C and begin to decompose and to form volatile substances at about 400°C. If such powders are utilised for production of mechanical pieces, it is necessary to take recourse to sintering, i.e. to shape such pieces by simultaneous application of heat and pressure.

Polytetrafluoroethylene is characterised by extreme chemical inetria, it can be attacked only by alkali-metals and is unaffected by acids, alkalis or solvents. It displays a good resistance to pressure and preserves its good mechanical properties at a wide range of temperatures. Neverthelss, this resin undergoes an appreciable deformation under the influence of a constant load. This deformation, however, tends to vanish when the load ceases.

The deformation increases as the work temperature rises while the "elastic memory" (i.e. the tendency to resume its original dimensions) is less affected. By using micro-powders of metallic titanium as a load material the tendency to deform displayed by p.t.f.e. is eliminated and the mechanical features of sintered pieces exhibit increased resistance to wear, permitting their use at higher rotational speeds.

As p.t.f.e. resin resists many chemicals, loading with titanium (instead of the usual copper or silver) improves its resistance to corrosion. Thus, sintered pieces produced in accordance with this invention are used for bearings that are subjected to heavy stresses in aggressive environments such as sea water.

The percentage of titanium added to the resin varies from 10% to 50% according to the use intended, mechanical stresses and the environmental conditions. The load of titanium powder not only increases the density (which, in the case of a sintered piece consisting of 50% of resin and 50% of titanium, by weight, passes from 2 to 2.8) but also increases the hardness which reaches some 4.6 or 4.8 as compared with 2.06 kg/mm^2 for the pure resin. Titanium displays more resistance to corrosion than copper or bronze and, in spite of its low specific weight, offers a mechanical resistance that is not inferior to that of traditional metals, especially at high temperature.

According to Italian Patent No. 802,736, the processing of powders, no matter whether continuous hot extrusion or die-casting is utilised, takes place along a cycle consisting of the following three operations: preforming, sintering, and cooling, as follows:

(i) Preliminary mixing of powder of p.f.t.e. (granules ranging from 0.25 to 600) and titanium (granules ranging from 40 to 200); the quantity of titanium ranges from 10% to 50% by weight;

(ii) Pre-shaping of the mixture in dies at pressure ranging from 4,000 to 6,000 kg/cm^2 and at environment temperature, in order to reduce the volume of the mixture to the size nearer that of the piece to be produced (the ratio is, usually, 4: 1);

(iii) Sintering of the preshaped mixture by means of heating in a stove, at the temperature ranging from 300 to 450°C, for one to three hours;

(iv) gradual cooling of the sintered piece to environment temperature.

5. APPLICATIONS

Pieces sintered from resin loaded with titanium are of interest for parts intended to work in acid environment, sea water, or oily mixtures, and subjected to corrosion and wear, friction and distortion stresses. They are useful for sleeves and guiding bushes, are useful for mechanisms opening and shutting sluice gates where standard metallic pieces are apt to jam because of dampness or dirt and also for mining winches cooled with water mixed with mud.

Gears built of resin loaded with titanium constitute pairs of gear-wheels that are very light and silent while displaying good mechanical resistance and low friction coefficient.

Sintered pieces in resin with high percentage of metallic titanium are capable of bearing considerable loads at limited linear velocities. Their use is advisable in cases when considerable stresses of brief duration have to be tackled; they are, therefore, suitable for water-cooled cylinders of rolling mills instead of bearings made of hard wood or of other resins which are apt to swell and crumble.

Sintered resin loaded with titanium powders constitutes excellent sheathing for large section bearings intended for propellers of large-tonnage ships and cooled with sea water. These bearings, used also in deck winches, can work at high rotation speeds and with considerable but constant loads, provided they are cooled with sea water.

6. CONCLUSION

It has been possible to use metallic titanium for the production of pieces that are not entirely of metal in which the features of such widely differing materials as metallic titanium and polytetrafluoroethylene mingle and create an entirely new material with extremely interesting characteristics.

A rainfall data supply system

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The daily tilting-syphon rain gauge, sometimes referred to as the "Dines" gauge, has been the standard automatic recording raingauge in New Zealand. There are about 120 in operation throughout the country, most of which have been in the country for 25 to 30 years. Thus, there is a large volume of records in existence. (Fig. 1).

The Meteorological Service has extracted some useful information from these archives manually. However, modern automatic data-processing equipment can tap this reservoir of information so much more efficiently and completely that many other useful facts that are hidden therein are exposed. These archives and modern data processing equipment have been brought together through a pencil follower device in the data supply system described in this paper.

Phillip James Thompson has been with the Ministry of Works since 1963 Until May 1966 he was involved in construction contract supervision including the d.c. transmission terminal at Haywards substation and highway realignments in the Buller Gorge. Since May 1966 he has been with the Water and Soil Division in head office.

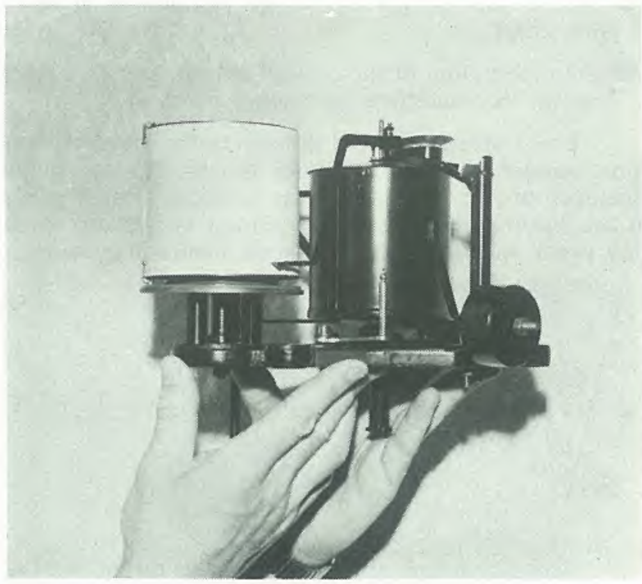

Fig. 1: The recording mechanism of a tilting syphon rain gauge.

THE SYSTEM

THE pencil follower consists of a special table and an electronic "pencil". A chart to be analysed is placed on the table and the pencil is passed over it. An automatic mechanism beneath the table surface follows the pencil and passes to a digital recording device a description of the trace followed by the pencil (Fig. 2).

These digital records serve merely as temporary buffers for the data until they are fed to a computer which sets up properly edited archives on a magnetic disc.

The system is operated by a hydrological field assistant who need have little knowledge of, and no previous experience with the pencil follower device or the computer.

The system is designed so that he can take maximum advantage of every mark on each chart. No special vetting of the charts is required before they are taken to the pencil follower. Thus the bulk of the charts need to be handled only once (Fig. 3).

Fig. 2: The pencil fo'lower.

One year of records takes between three and six hours of pencil-follower work depending on the actual quantity of rain recorded.

Two criteria were used in the design of the system:

- That it must accept all the information inherent in any chart.
- The preparation of the rainfall information files must involve the minimum of manual effort (Fig. 4).

These criteria defined objectives for the computer programmes; that the computer should check as many features of the information as possible, and that as much information as possible should be gleaned from the pencil follower output without manual interference.

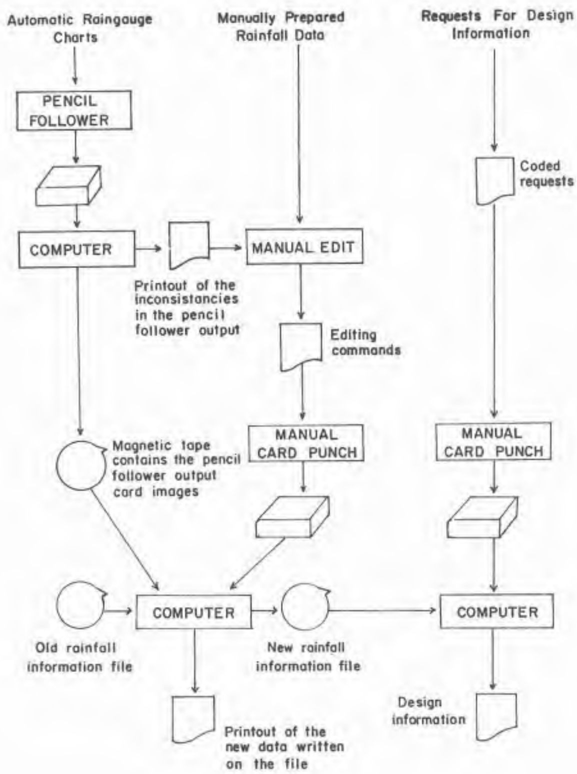

Fig. 4: A flow chart of the system.

This is a summary of a paper submitted by **the author in May 1970. Copies of the original paper can be obtained by application to the author, care of the Ministry of Works, Water and Soil Conservation Division, P.O. Box 12041, Wellington.**

Fig. 3: A sample daily tilting syphon rain gauge chart.

The first objective was achieved to the degree that the only errors which can be passed undetected are those which result from an inaccurate placing of the pencil follower pencil, and then only when the resulting reading could be meaningful.

To achieve the second of these objectives various assumptions as to how errors are to be corrected were written into the programme. The possibility that one of these assumptions is wrong in any particular case necessitates a manual edit of the information. One of the listings output by the computer is specially designed for this manual edit which takes about one hour for each year of records.

CONCLUSION

The fund of useful facts as yet hidden in automatic rain-gauge records could have some impact on our hydrological design techniques, and the system is a significant step towards gaining access to this fund.

ACKNOWLEDGMENT

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Developments in engineering education in Australia - with particular reference to Diploma courses

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This paper briefly surveys the field of professional engineering education in Australia and makes special reference to the role of diploma courses in that country. It is intended as a largely factual contribution to the discussion of the development of engineering education in New Zealand.

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joined Massey Ferguson (Australia) as a laboratory test engineer, and later became assistant project engineer. During 1965 and 1966 he worked with the Victorian Department of Agriculture and in 1967 joined the New Zealand Agricultural Engineering Institute as research officer. He was appointed lecturer in the Agricultural Engineering Department in 1968 and to his present position in 1970.

1. ENGINEERING EDUCATION IN AUSTRALIA

PROFESSIONAL engineering courses in Australia may be broadly divided into four main categories:

(i) Four-year* university courses in engineering leading to Bachelor of Engineering degree.

(ii) Six-year, part-time university courses in engineering leading to Bachelor of Science (Technology) or Bachelor of Science (Engineering) degrees and three year, full-time courses leading to Bachelor of Technology degrees.

(iii) Four-year courses at certain institutes of technology leading to degree qualification.

(iv) Three or four-year, full-time (or equivalent part-time courses) at technical colleges, institutes of technology or similar establishments leading to a Diploma of Engineering.

2. UNIVERSITY COURSES FOR BACHELOR OF ENGINEERING

These four-year, full-time B.E. degree courses are similar to their New Zealand counterparts. Nine universities have engineering schools with courses covering the usual engineering fields as well as some of the less common, viz., mining (5), metallurgical (3), industrial (3), aeronautical (2), agricultural (1), fuel (1).

TABLE I

Professional engineers (P.E.) qualifying from all Australia

Year	*University*	*Institute*	*Other*	*Total*	*% Institute*	*All P.E. per 100,000 pop.*

Table I (Lloyd') shows the number of professional engineers qualifying with university B.E. degrees in relation to the total, and indicates how university output has doubled in the nine-year period from 1956 to 1965. All courses qualify for admission to Graduate membership of the Institution of Engineers, Australia, and after three years suitable professional experience graduates may qualify for Corporate membership-M.I.E. Aust. In most instances the B.E. degree is recognised as giving exemption from Parts 1 and 2 of the C.E.I. examinations.

* All course years referred to are on the basis of entry with six years secondary education, i.e. matriculation or university entrance.

This paper was received 11 February 1971 and has not been revised.

It is estimated that while about two-thirds of all full-time university undergraduates receive some form of financial assistance the proportion of engineering students receiving assistance is less than this. Fees for the B.E. course vary from $1,200 to $1,700.

3. UNIVERSITY DEGREE COURSES IN TECHNOLOGY AND SCIENCE (ENGINEERING)

These courses are relatively new and have introduced features which are unique to engineering education in Australia.

3.1. B.Sc. (Tech) and B.Sc. (Eng)

These courses which are taught at the universities of New South Wales and Newcastle respectively, offer the only opportunity to obtain a university engineering degree on a part-time basis. They are essentially six-year, part-time versions of the standard four-year, full-time B.E. degree courses at these universities and students may transfer from one such course to another.

The Newcastle B.Sc. (Eng) courses (originally B.Sc. (Tech) of N.S.W.) comprise an average time of 2016 hours including 560 hours basic science which are 82% and 87% of the corresponding hours for the B.E. degree. These are composed of subjects which are identical with those of the B.E. degree, but certain electives are omitted.

3.2. B.Tech

This three-year-course, which was taught by the South Australian Institute of Technology (with the degree being awarded by the University of Adelaide) is to cease and revert to a Diploma in Technology.

The course hours given to the various subject groups in the university degree courses are shown in Table II. The figures suggest that the B.Tech and B.Sc. (Tech) courses do not have the theoretical and analytical content in the "engineering science" and "advanced engineering" groups to rank with the B.E. degree, nor do they have sufficient "advanced engineering" and "practice of engineering" to equate with the more practical diploma.

Students apparently had considerable difficulty in reaching degree standard in the three-year B.Tech course and the result was a "four-year" course which was below B.E. degree standard. The progress of students is another problem with the part-time courses and Short- reports graduation rates from part-time engineering courses at the University of New South Wales were 5% in minimum time and 15% ultimately. These three-year full-time, and six-year part-time, courses in technology have invoked considerable discussion within the profession and in this respect the comments in the Martin Report are relevant.

"The committee is concerned about the recent introduction of three-year courses leading to the award by universities of a baccalaureate in technology . . . the committee is of the opinion that the award of a first degree in these disciplines after a three-year course must represent a lowering of the standards formerly maintained. . . . The committee, therefore, recommends that courses of three years' duration should be confined to the technical colleges and lead only to the award of a diploma. Undoubtedly those obtaining this qualification are satisfying a very real need in industry. The recognition whicn should be accorded to them is of course a matter for the professional bodies concerned."

The report later implies (p.152) that these comments also apply to the six-year, part-time B.Sc. (Tech) course at U.N.S.W. which at that time included the Newcastle University College. It further states that these university courses in technology should be lengthened to four years but feels strongly that diploma courses equivalent to three years' full-time study should be available in all states and, in addition, diplomates should have the opportunity to obtain a degree in technology after a further year of study.

4. INSTITUTE DEGREE COURSES

Full details of these courses are not available but they will be introduced for the first time in 1971 at a limited number of institutes and will cover the more common fields of engineering as well as some non-engineering disciplines.

The four-year, full-time courses are based on the existing three-year diploma structure, having some or all subjects common in the third year, and provide for a fourth year of advanced study. One part-time sandwich version of the above occupies five years, the third and fourth being spent partly in industry and partly in study over an 18-week semester period. The academic content of this course will be the same as the full-time equivalent. The justification for institute degree courses is based on the large demand for post-diploma courses and for advanced study based on the more practical technical institute approach.

It is understood that accreditation by the Institution of Engineers is to be sought and that courses at other institutes are under development.

5. INSTITUTE DIPLOMA COURSES IN ENGINEERING

An important characteristic of professional engineering education in Australia is the existence of some nine technical colleges, institutes of technology or groups of such institutions. These institutes and colleges offer diplomas which are available on a full-time or part-time basis and at two levels. The Diploma (or Associateship Diploma) is a three-year, full-time course or a six-year, part-time course. Three of the above institutions also offer Fellowship Diploma courses involving an extra year's full-time or equivalent part-time study.

Table I, which shows the number of professional engineers qualifying, indicates that while the number qualifying with diplomas has risen, the proportion has been reduced due to the marked expansion in the numbers qualifying with university degrees.

Four questions may be asked about a course of education and training which claims to be a suitable and distinctive basis for entry to a profession.

5.1. Is it of an adequate academic standard?

Any course should be judged on its merits, but it is convenient to compare it with other accepted courses to judge its adequacy not to be confused here with equality.

TABLE II

Average course hours—professional engineering courses in Australia

Table II (Lloyd') gives the analysis of the average diploma course hours in relation to the other professional courses by subject groupings. The important features of this are the relatively small number of hours given to basic science in the diploma course and the large number given to the practice of engineering. Also, almost as many hours are involved in the three-year diploma as in the four years of the B.E. degree.

The Institution of Engineers, as guardian of professional standards in Australia, has laid down in a general way the academic requirements of courses which are acceptable for entry to Corporate membership. These are expressed in terms of the standard of entry, length. breadth and depth of the courses.

In 1967 the Institution reviewed the length requirements and, allowing sufficient time for courses to be altered, announced that as from June 1980:

- A course must be of not less than four years' duration for a full-time course after a standard of secondary education not less than the general standard of examination for matriculation to an Australian university.
- A part-time course must be of sufficient duration to allow a similar standard to the four-year, full-time course after a similar standard of secondary education.

Many existing diploma courses will therefore have to be lengthened by one year beginning in January 1976 if they are to retain professional status. It would appear desirable that the extra time available should not be used to substantially increase the course hours but rather should allow greater freedom for students to pursue topics of interest in depth.

The Institution requirements, as far as breadth and depth are concerned, are contained in its statement of policy in January 1958.

(i) *Breadth:* This need is met, in the first instance, by the requirement of matriculation or its equivalent, and by suitable standards of instruction—such as two complete years of a normal university course—in the fundamental sciences and in the basic principles of civil, mechanical and electrical engineering and the properties of materials. These requirements are fairly well understood and present little difficulty in interpretation.

(ii) *Depth:* It is expected that, in one substantial engineering discipline at least, the full course of instruction should reach such a level that the graduate is able to read critically the scientific literature describing recent advances in his subject. This study in depth should follow, and depend on, the basic studies particularly in the fundamental sciences. In addition, the main discipline should be supported by appropriate complementary subjects.

The diplomate would not be in as good a position as his graduate counterpart: "to read critically the scientific literature describing recent advances in his subject", where this is interpreted as being fundamental research findings. On the other hand his extensive training in the practice of engineering probably places him in as good, if not a better, position than his graduate colleague to keep abreast of developments in design, production and construction techniques.

5.2. Is it professional?

This question may be answered partly by stating that the diploma is recognised as such by the profession. The Institution has accepted it as a suitable basis for granting graduate membership since 1920, and corporate membership (M.I.E. Aust.) may follow after a period of suitable professional employment. In the case of the diploma the minimum length of the employment is four years—one year longer than that for a degree. In any circumstances the applicant must be 25 years of age. A further stage in recognition came in 1961 with the Professional Engineer's Award which treated graduate and diplomate alike in the minimum salary payable to a "qualified" and to an "experienced" engineer.

One aspect of the term "professional engineer" is the important distinction it draws between what is truly engineering, and what might be termed "applied science"; while the intellectual approach is similar in both, it is necessary to distinguish between them. The diploma, like the degree, is in danger of becoming an "applied science" qualification in some fields. However, in so far as the diploma gives considerable emphasis to the practice of engineering, including engineering design, this tendency is probably less than for the degree.

A second aspect of the term "professional engineering" is the distinction which it attempts to draw between *work,* which is correctly called by that name, and that which is *technical* or *sub-professional.* The difference between the two is, however, not always clear. Ultimately the question of professionalism must be answered in terms of the work performed by, and the personal attitudes and standards of, those who qualify by this course. The acceptance of the diploma as a professional qualification is by "definition" rather than by "proof" and the question as to whether the definition is correct is still open to argument. The diploma would appear to fulfil the requirements of professionalism but not in exactly the same way as does the degree. This raises the third question in relation to the two qualifications which the Institution accepts.

5.3. Is the diploma different from other courses?

This leaves aside the question of whether the diploma qualification is needed and seeks to clarify the difference which exists between it, and the B.E. degree.

The university and institute systems have developed concurrently in Australia from the early part of the century and there is little doubt that these courses are less different than they were some years ago. This has been mainly due to the rising academic standard of the diploma, a movement encouraged by the Institution. There are, however, still fundamental differences in approach between the two courses, and it is important that they be maintained.

The Martin Report[5],6, in promoting the development of institutes: "insists that they should resist the temptation to copy the educational processes and curricula of universities. The committee envisages a greater diversity of tertiary education in Australia, but any hope of achieving this diversity would be nullified if colleges attempted to transform themselves into universities. The responsibilities of colleges to the community are of a different kind. . . .

The function of the diploma is to provide a more practical form of education as an alternative to the universities with their emphasis on scholarships and research."

In general, the diploma differs from the degree in that it is less theoretical and more applied, less "research" orientated and more "design and production" orientated. One of the reasons for this is the underlying concept that the diploma system provides a vocationally orientated qualification. Another reason for the difference between degree and diploma courses is the changes in approach which have taken place within the degree system.

". . . there can be no doubt that the natural direction of change within university engineering schools is towards increasingly analytical and theoretical courses . .. with the increasing emphasis on analysis and generalisation has gone a decreasing emphasis on design especially at the drawing board level and laboratory work". (Titchener7)

Although written of New Zealand, Australian courses have developed in a similar manner. Some of the differences in emphasis will be seen in the smaller numbers of hours given to basic science (mainly physics and chemistry) and the larger number to the practice of engineering in the diploma, when compared with the degree.

The dual system of professional engineering may be justified, but one necessary condition is that the two courses are different in objective and approach and result in qualifications which are distinguished by their respective names. Any move to change the type of course given in the diploma and make it like a degree, immediately removes the very fact that justifies the existence of the diploma in the first instance.

5.4. Is it necessary?

Although the answers to the three previous questions may be in the affirmative, the important question is: given a course can be devised which has an adequate standard, is professionally acceptable and is different in orientation to the degree, is such a course needed, and should a dual system of professional engineering education be provided?

This question must be answered in terms of the needs of students for an education suited to their aptitudes and interests, and of society for professional skills at two levels.

"It is necessary to reconsider within the context of contemporary economy and society what education is; what are now the main types, forms, areas or levels of tertiary education; what are the different categories of students who want or should be offered, higher education—students different in intellectual capacity, aptitudes, interests and motivations; what are the different kinds of institutions that should exist to provide for these distinguishable types and levels of tertiary education; what are or should be the educational aims or functions of the main separate types of institution that comprise the system of higher education" (Partridge8).

In considering the population of potential engineering students this paper is concerned with the group that pass Australian matriculation (equivalent to New Zealand U.E. certificate). In Australia the situation will be similar to that in New Zealand described by

"The sample reaching university has a strongly skewed distribution of abilities with the population heavily concentrated just above cut-off line. In the first year at university another heavy cut is made, viz., about 40% of engineering intermediate . . ." and ". . . thus about 60% of the initial intake into the Engineering Intermediate level never complete a B.E. degree."

The comparable Australian figure for those who fail to graduate as a percentage of those who enrol is approximately 35%.

Some of those who fail at university in Australia continue their studies at technical institutes along with a larger group who fail to gain entrance to university in spite of good matriculation results. The academic abilities of technical students could, therefore, be expected to be somewhat lower, but overlapping, that of university students and having a similarly skewed distribution with cut-off at matriculation.

It may be said that technical institute students differ in their educational needs as far as type of course is concerned.

"Courses in engineering offered by the colleges are designed for students whose aptitudes and motivations are responsive to vocational incentives. Courses are related more to the everyday practice of engineering rather than to research and scholarship. . . ."

"It is important that students receive the kind of education best suited to their inate abilities and purposes in life. At present certain pressures tend to overtax the academic ability of a considerable segment of the student population which could be better provided for in institutions offering courses of different orientation and less exacting academically" (Martin Report").

University places in some Australian engineering schools have failed to keep pace with the demand and the minimum entry standard has therefore been rising in order to limit the numbers of students to a predetermined quota. It is probably as a result of this and other factors, the overall standard of the Australian degree has also been rising in recent years. However, the standard of entry to the profession does not rise in an arbitrary way with the number of university places available. The availability of non-university courses means that many students of average to good ability who gain matriculation but who do not gain entry to university or who do not seek it, have the opportunity to become professionally qualified.

The second aspect of the question of the necessity for a dual educational system is whether employers need professional engineers of both types.

It will be understood that employers in Australia have grown up with the idea of having a choice between a graduate and diplomate to fill various types of positions. While some organisations prefer one or the other most positions are advertised in terms of qualifications acceptable for Corporate membership of Institution and any preference is not stated.

In general the diplomate is accepted in most types of engineering employment as fulfilling a work role between and overlapping the graduate on the one hand and to a lesser extent the technician (certificate holder) on the other.

6. CONCLUSION

Engineering education in Australia has been marked in recent years by the establishment of a number of new university schools and more recently by the very rapid development of the technical institute system.

Similar developments are largely at the discussion stage in New Zealand and it is important that this country does not adopt overseas methods without due consideration. It is equally important that those developments which do take place should meet the needs of all students for a suitable education, and the needs of the industry for staff at all levels. This subject deserves the widest possible consideration within the profession and it is hoped that this paper will serve as background material on one aspect of the Australian scene.

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"The Martin Report (1964-5): P. 165.

PAPERS AND ARTICLES RECEIVED

THE following have been received by the N.Z. Institution of Engineers:

J. J. Hughes—"Conference—computers in construction communications."

C. Vautier—"Transport needs in the Waikato-Bay of Plenty region."

M. J. N. Priestley—"Structural model of a waffle-slab bridge deck."

J. W. Henwood—"Shear load transfer across rubber ring joints in ceramic pipes."

Hydraulic design of gravity flow in sewers

F. H. PEARSON
B.E., M.SC. (MEMBER)

FRANK HENRY PEARSON is design engineer, public health, at the Ministry of Works. Born in Wellington, he graduated in 1962 and in 1967 obtained a M.Sc. (Applied Science) in water resources at the University of Newcastle-upon-Tyne, Britain, where he was awarded the Chadwick Medal for excellence in Public Health Engineering 1966-67. He is now studying towards a Ph.D. degree at the Civil Engineering Department of Pennsylvania State University.

*His practical experience was received during three years with the Ministry of Works in the Haast, South Westland area on investigations for, and construction of, highways and bridges. This was followed by five years in the Ministry of Works public health engineering design office on the design of sewage treatment plants and technical work in connection with water supply and particularly sewage disposal. He is a member of "pipe loading and laying committee" of the Standards Asso-*ciation of New Zealand. He was co-author *of "Water quality management" presented at the N.Z. Water Conference 1970 and author of two papers published in* N.Z. Journal of Hydrology, *one of which was presented at the 1970 International Symposium of the International Association of Scientific Hydrology.*

1. INTRODUCTION

POMEROY[1] proposed a new equation for the velocity of flow in small sewers based on measurements of flow in sewers and some theoretical considerations. The equation was:

$$V = 1.40\, K_i Q^{0.24} S^{0.41} \qquad (1)$$

V = *velocity* (ft per sec)
K_i = friction coefficient
Q = flow (cusec)
S = *slope* (ft per ft)

The mean value of Ki for various types of pipes was 17.6.

Equation (1) is valid where the depth of flow is up to 90% of the sewer diameter; a sewer will carry more when flowing 90% full than when it flows full bore.

Equation (1) can readily be transformed to a form more suitable for design purposes. This form relates velocity to resistance coefficient, slope, sewer diameter and depth of flow as a proportion of diameter (proportional depth of flow). Figure 1 graphs this relationship, using a value of 17.0 for Ki (see Table I).

2. DESIGN PROCEDURE USING FIGURE 1

Refer to Fig. 1.

For velocity, locate the intersection of flow and slope on the top part of the graph, and read down the sloping velocity line to the right.

Sewer diameter is determined from the maximum design flow. Locate the intersection of maximum design flow and slope on the top part of the graph and cast vertically downward to intersect the first diagonal on the bottom part of the graph.

This diagonal represents the sewer diameter.

For proportional depth of flow, locate the intersection of flow and slope on the top part of the graph, cast vertically downward to the bottom part to intersect the diagonal that represents sewer diameter, and read horizontally to the left.

This paper was first received on 4 February 1971 and in revised form on 27 April 1971.

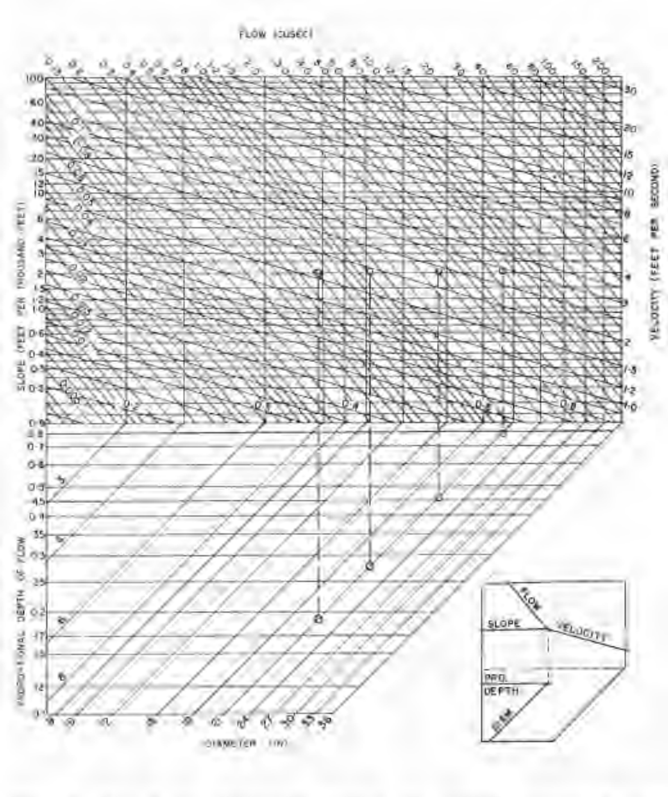

Fig. 1: Graph for hydraulic design of sanitary sewers based on $V=1.40K_iQ^{0.24}S^{0.41}(K_i=17.0)$.

2.1. Worked example

A sewer graded at two feet per thousand feet is to carry the following flows:

Initial minimum flow	0.5 cusec
Ultimate minimum flow	1.0 cusec
Ultimate mean flow	2.0 cusec
Ultimate peak flow	6.0 cusec

Solution

Intersections of flow and slope are shown as circles on the top part of Fig. 1 and intersections representing the proportional depth of flow with the sewer diameter are shown as circles on the bottom part of Fig. 1.

The required sewer diameter is 21 in.

Velocities and proportional depths of flow are as follows:

3. VARIATIONS OF EQUATION (i) AND OTHER FLOW EQUATIONS

Equation (1) relates velocity to flow and slope, whereas most flow equations relate velocity to hydraulic radius and slope. Hydraulic radius is equal to the volume of water per unit length of pipe divided by the area of internal pipe surface wetted by the flow per unit length. Commonly used equations of the latter type are Manning and Hazen-Williams, respectively:

$$V = 1.49n^{-1}R^{0.67}S^{0.50}$$

$$V = 1.32\,CR^{0.63}S^{0.54}$$

R= hydraulic radius (ft)

Observations of flow in sewers presented by Pomeroy[1] provide an opportunity to check the accuracy of the two types of equation, and to see if their accuracy can be improved.

The forms of the two types of equations are:

$$V = aQ^bS^cD^d$$

$$V = eR^fS^g$$

Least squares values of the logarithms of coefficients (a and e) and exponents (b, c, d, f and g) were calculated leading to the following equations:

$V = 1.42K$

$V = 1.59K_{iv}R^{0.61}S^{0.64}$ (feet-second units) . . . (4)

Diameter D does not appear in equation (3) as it was not significant at the 10% level within the range of the observations made.

In an earlier study Pomeroy[2] showed that velocity is proportional to the 0.29 power of flow. The value of the exponent (0.29) compares well with the exponent of Q in equation (3) (0.30) but not with the exponent of Q in equation (1) (0.24). As little support was given by Pomeroy to this aspect of equation (1) the evidence appears to favour equation (3).

In equation (4) the exponent of R is less than, and the exponent of S is greater than in either the Manning equation or the Hazen-Williams equation. Equation (4) indicates that slope is at least as significant as hydraulic radius in governing the velocity of flow in a sewer, whereas the other formulae would indicate that velocity is less sensitive to slope than to hydraulic radius.

The multipliers in front of equations (1), (2), (3), (4) and the Manning equation disappear when these formulae are used in metre-second units rather than foot-second units.

A form of equation (1) which is suitable for evaluation by slide rule is:

$$V = K_vQ^{1/3}S^{1/2} \quad (5)$$

which may be used in either ft/s or m/s units. To evaluate equation (5) set K on the reciprocal scale opposite Q on the cube scale (using the cursor), then read V on the D scale opposite S on the B scale (again using the cursor). Pipe diameter may be determined from maximum flow and velocity (Q^* and V^*) as the next larger available diameter than D^*:

$$D^* = 16.1(Q^*/V^*) \quad \text{in.}$$

or 4 in., whichever is greater.

4. ACCURACY OF FLOW EQUATIONS

The distribution of observed velocity divided by calculated velocity for 183 observations is plotted in Fig. 2 as a histogram for each flow equation. In each case the value of the resistance coefficient *(K, n* or C) was selected such that the mean observed over calculated velocity is equal to unity, so that on the average all formulae give the correct answer for these values of resistance coefficient, which are the mean observed values of resistance coefficient.

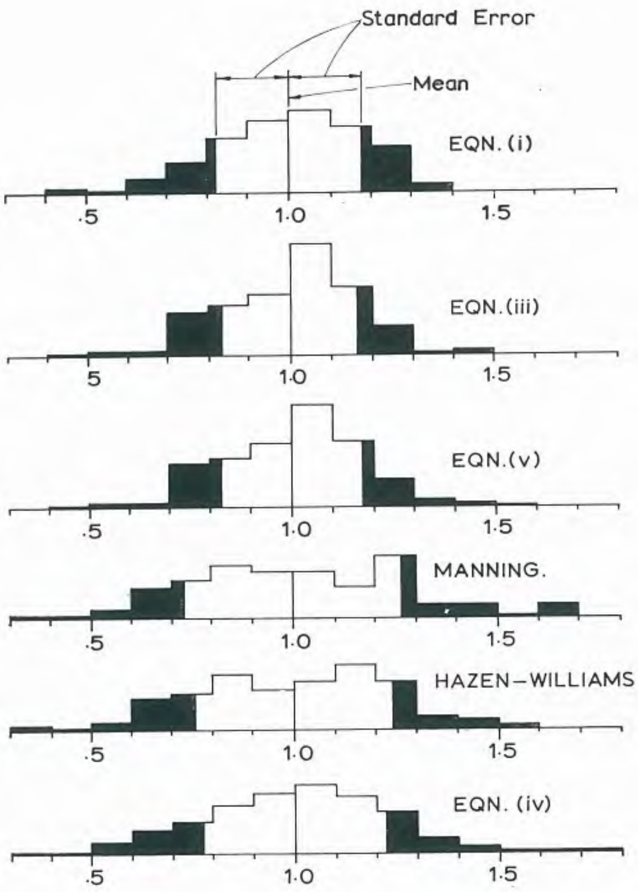

Fig. 2: Distribution of observed velocity divided by calculated velocity according to different equations.

The accuracy of each equation is measured by the standard error (standard deviation) of observed over calculated velocity. Two-thirds of values of observed over calculated velocity are within one standard error of the mean.

Standard error divided by the mean is known as coefficient of variation. The coefficient of variation of observed over calculated velocity is equal to the coefficient of variation of the resistance coefficient.

For each equation the mean value and coefficient of variation of the resistance coefficient were calculated, first for 183 observations of flow in all pipes as a group, and then for each type of pipe material separately. Eighty-eight observations of flow in asbestos cement pipes, seventy observations in ceramic pipes and twenty-five observations in concrete pipes were analysed. Values of the mean and coefficient of variation of resistance coefficient appear in Table I.

Also in Table I are suggested values of the resistance coefficient for all types of pipe for each equation. These values have been selected such that velocity is under-estimated about 60% of the time; that is 60% of the time the design is conservative.

The relationship between the different resistance coefficients for the various equations is statistical and not fixed, because different equations assign different exponents to the several factors influencing flow velocity. From Fig. 3 the mean value of Ki (in equation (1)) or Kv (in equation (5)) can be read for any given value of Manning's n, using the full line. The broken lines represent two-thirds confidence limits for Ki and

In the Manning equation the resistance coefficient n has been observed to vary with proportional depth of flow. The loss in accuracy with the Manning equation owing to this effect can be reduced only by a subsequent step in the calculation. For equations (1), (3) and (5) there was no significant variation of resistance coefficient with depth at the 5% level.

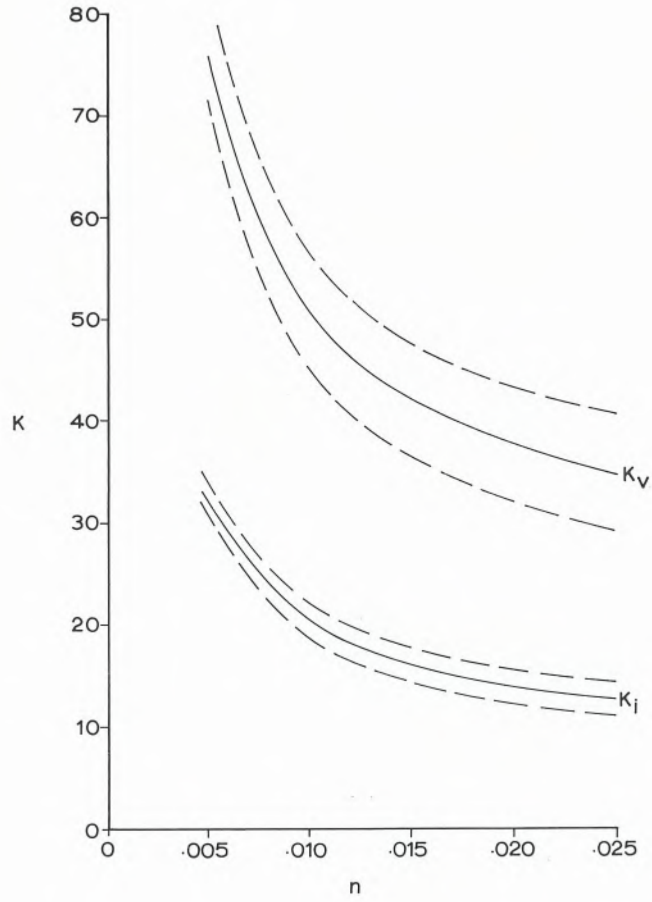

Fig. 3: Graph for obtaining value of resistance coefficients in proposed design equations which are equivalent to given values of Manning's n.

TABLE I

Values of the resistance coefficient in various equations for flow in sewers.

CV COEFFICIENT OF VARIATION *C V of n-'

5. CONCLUSIONS

(i) Based on published observations of flow in sewers between 6 in. and 24 in. diameter, two new methods of hydraulic sewer design, are presented, one graphical method and one slide-rule method.

(ii) The standard error of velocity as calculated by these two new methods is two-thirds the standard error of velocity calculated by the Manning equation, and three-quarters the standard error of velocity as calculated by the Hazen-Williams equation.

(iii) According to the Manning and Hazen-Williams equations, flow velocity is more sensitive to hydraulic radius than slope. Analysis of the observations indicated that in sewers velocity depends on slope at least as much as on hydraulic radius.

(iv) Observed mean values of the resistance coefficient in each equation are tabulated separately for asbestos-cement pipes, ceramic pipes and concrete pipes, and also for all pipes together. The coefficient of variation of each observed resistance coefficient is tabulated. Design values of the resistance coefficient in each equation are suggested for use with all types of pipe.

(v) For any single equation mean values of the resistance coefficient for different pipes (and also for all pipes together) often differ significantly from each other and also from the suggested design value. However, the designer is generally less concerned with the mean value than with the distribution of resistance coefficient, and in no case does the suggested design value coefficient differ from the mean value by more than one standard deviation.

6. ACKNOWLEDGMENT

The permission of the Commissioner of Works to publish this paper is acknowledged.

7. REFERENCES

[1] POMEROY, R. D. (1967): Flow velocities in small sewers. *Jour. Water Pollution Control Federation, 39 (9),* p. 1525.

[2] POMEROY, R. D. (1961): Flow velocities in partly filled pipes. *Water and Sewage Works, 108 (5),* p. 180.

Consultants' Notebook

Bluff Smelter Wharf

RECENTLY completed by the Southland Harbour Board for use by New Zealand Aluminium Smelters Ltd., the Bluff smelter wharf will provide berthage for bulk carriers up to 68,000 tons displacement and outward bound cargo vessels carrying aluminium ingots. The completed cost will be in the order of $2,000,000.

The wharf is 655 ft by 57 ft, and is sited on the east side of Bluff Harbour opposite the existing Island Harbour. It is connected to the Tiwai Peninsula, where the smelter is sited, by a 4,170 ft long single lane approach bridge with two passing bays. Most of the approach is over shallow water. The wharf area is exposed to strong winds and tidal currents of 3 to 4 knots at spring tides.

Although preliminary investigations and siting proposals had been under way for some years, final siting and instructions to proceed with working drawings was not received by the conmeant a very tight design and consultants until late August 1968. This struction programme to allow tenders to be called by mid-December 1968 and substantial completion to be achieved within two years of letting a tender. Soils investigations were carried out concurrently with the design, original assumptions of soil properties being reviewed against information received as the design proceeded.

The wharf is an open piled structure, with a precast concrete superstructure assembled by post tensioning. Piles are generally 85 ft long 24 in. octagonal hollow pretensioned units, with a capacity of about 130 tons. The necessary 30 ft of pile penetration was achieved by jetting and final driving with a diesel pile hammer. The standard of accuracy of pile placement required for receiving the precast deck units was achieved by the use of a pile on permanent piles already driven and frame mounted on a rigid deck seated steel spud legs. The approach, which was constructed concurrently with the wharf, consists of precast pretensioned 30 ft span deck units, seated on precast pile caps and precast pretensioned 17 X 17 vertical piles. The contractor adapted the bridge launcher used for the Awarua Bay bridge (see Consultants' Notebook, February 1971) and achieved the remarkable rate of progress of one 30 ft span of single lane bridge per day for sustained periods. All precasting was carried out by the contractor in a factory set up for the purpose on the Island Harbour, and units were barged across the harbour to the wharf and approach.

The design and construction of the vacuum unloader and the conveyor system to the wharf was arranged by Kaiser Engineers and Construction Inc. As the design of this equipment was not completed until wharf construction was well advanced, it was necessary for the consultants to review and modify the original wharf designs, based on assumed loadings and conveyor structure layout, as work proceeded.

The contractors were Messrs. Wilkins and Davies-Taylor Woodrow International, a joint venture. The Southland Harbour Board, working in consultation with the users, were responsible for siting of the wharf. The board's engineering staff designed the fendering system and wharf furnishing and provided day-to-day supervision under the general direction of the board's consulting engineers, E. R. Garden & Partners.

INDUSTRIES DIVISION

WHERE WE ARE HEADING

INDUSTRIES Division members* have more diverse backgrounds and interests than engineers in any other division. Moreover, they include employers and employees, and the management committee has kept this firmly in view right from the inaugural meeting in February 1968.

Those present at this year's annual general meeting were given a review of present policy, and they broadly confirmed the committee's practice of applying a test to all suggested lines of action—the question of "What's in it for me?".

The decision exists, therefore, to help members to better themselves and improve the contribution that professional engineers make to industry in New Zealand. How we set out to do this can be seen from the topics introduced at meetings, some of which are mentioned below.

There is, in fact, a distinct pattern emerging of common interests, and this is a timely opportunity both to record the recent past and provide N.Z.I.E. members at large with more background to these interests. Among others we have heard :—

Industry needs a more positive contribution from engineers

Professor G. J. Schmitt gave the first major I.D. meeting held, a summary, backed by statistics, of the relatively poor results New Zealand industry achieves by modern world standards—capital investment lying idle for too much of the day and insufficient importance attached to management techniques. Engineers need to advertise their role more effectively within their organisations and study management as a subject so they are better equipped.

Can graduates be better prepared for industry

Professor A. L. Titchener, at a later meeting, gave a summary of what the raw graduate is, and is not, capable of tackling without further training. This provoked much discussion which underlined the need for closer liaison between all parties involved—and I.D. members seemed to be present in all camps.

The organisation and functioning of the Department of Industries and Commerce

In Wellington B. Hickey gave an extremely useful insight into this department's role, but unfortunately no paper was published.

What industry expects from its engineers

J. T. Currie, the resident director of New Zealand Forest Products, Kinleith, opened the one-day 1970 Divisional Conference in Auckland with a paper on this subject which, in a sense, balanced the earlier one by Professor Titchener.

Improving productivity through T.W.I.

This paper by P. C. Romanovsky, group training officer of Alex Harvey Industries Limited, together with another on the scheme by R. A. Adams of the Labour Department were also discussed at the same conference.

Summaries of these and earlier papers with the discussions were available in limited numbers to members at the time. However, it became obvious that wider circulation of such topics is justified and the Division has offered more recent papers for publication in *N.Z. Engineering* and some are currently being considered by the Publications Committee.

**Membership of I.D. is open to all N.Z.I.E. members "working in an industrial or commercial organisation". There is currently no extra fee for membership, beyond the existing N.Z.I.E. subscription and it is hoped that more eligible N.Z.I.E. members will register with this Division as they come to realise what it has to offer.*

Applications for membership should be made to:

Hon. Secretary: P. D. Preston,
31 Copeland Street,
Lower Hutt.

CORRESPONDENCE

Sir,

Correspondent S. A. Vincze (N.Z. *Engineering, 26 5,* p. 146) suggests that the raising of Lake Manapouri could be avoided by the installation at Bluff of a 35 MW base-load diesel power station.

What your correspondent has failed to appreciate is that the figure of 222 GWh per annum upon which he develops his argument is the *long-term average* of the difference in energy output of the Manapouri scheme at lake levels of 583 ft and 610 ft. Careful study of the hydrological records since 1935 shows that if the lake is not raised the shortfall in meeting Comalco's entitlement under the agreement is less in some years, and at other times very much more. To ensure the company the supply of continuous power so necessary to the type of operation in which it will be engaged it woud require the provision of a standby/firming-up thermal power station of not less than 150 MW capacity, lying idle for a large part of the time, ready for use at times of low water inflows.

This was the basis of the comparisons made in the Cabinet Committee Report, to which Mr Vincze referred, and which was presented before the Commission of inquiry. The matter was the subject of lengthy cross-examination and the Commission's conclusions were as follows:

> "On the question of the capacity of alternative plant to make good the shortfall if the lake is not raised, the Commission accepts the view of the Electricity Department that it should be of the order of 150 MW rather than 50 MW or 60 MW as suggested by other engineers. While the opinions of the engineers called by the conservation interests are entitled to great respect, none of them has had the experience under New Zealand conditions of operating a system comprising inter-connected hydro and thermal stations as have the engineers of the Electricity Department. It seems to the Commission that a capacity of 50 MW or 60 MW is inadequate to cope with dry year conditions and to supply the continuous power required by Comalco under all conditions except those extreme conditions which might be covered by the force majeure clause. . . . Having regard to the evidence, we conclude that the annual cost of alternative sources is now something in excess generating capacity from thermal sources is now something in excess of $2 million, and that with the rise that can be anticipated in operation and maintenance costs, it will increase as the years go by."

Another point of interest is that not only is Mr Vincze's suggested solution quite inadequate to meet the requirements, but it is completely at variance with the theme of his article in *N.Z. Engineering, 26* 1.

In this he advocates keeping to a bare minimum the burning of combustible fuel, to avoid the possibility of long-term adverse effects on the earth's atmosphere. In fact, one of his specific recommendations is that combustible fuel-burning thermal power stations should be phased out and all future power stations should be hydro-electric, geothermal, nuclear, aeolian, and solar.

I am, etc.,
P. W. BLAKELEY,
Wellington.

PERSONAL

Overseas project

South Korea and the Maktong River is the destination of retired Ministry of Works senior river engineer, T. H. F. NEVINS, C.Eng., M.I.C.E., F.N.Z.I.E., of Wellington.

He will be a member of a team of engineers from an Australian firm who are acting as consultants to a United Nations development agency which is taking part in projects on the Maktong River.

The team will be studying flood and erosion control.

Mr Nevins was a senior soil conservation and rivers control engineer with the Ministry of Works for over 40 years. During the Second World War he was engaged on railway surveys, including the reconnaissance of 400 miles of desert for a railway between Egypt and the Sudan. For his work in the Sudan, Mr Nevins was made a fellow of the Royal Geographic Society in 1947.

After the war Mr Nevins worked on the design of the multi-million dollar Damador flood control scheme to provide irrigation and hydro-electric stations in the Bengal and Bihar provinces of India.

Design appointment

H. ELDER, B.E., C.Eng., M.I.E.E., M.I.Mech.E., M.N.Z.I.E., has joined Beca Carter Hollings & Ferner (Auckland office) as senior air conditioning engineer For the past seven years he has been engaged in building service work, latterly with Stephenson and Turner, Wellington.

Mr Elder is a member of the Council of the New Zealand Institute of Heating and Ventilating Engineers. He has also been serving on the Wellington branch committee, N.Z.E.I. and as secretary, Wellington branch of the Building Services Group (of whose management committee he is also a member).

In recent years he has specialised in the design and contract supervision of electrical, plumbing, heating, ventilating and air conditioning services in commercial buildings and factories.

Partnership

DAVID REID WILKIE, B.E., C.Eng., M.N.Z.I.E., M.I.C.E., has recently been taken into partnership by Steven & Fitzmaurice, consulting civil and sanitary engineers, of Christchurch and Auckland.

He joined the practice in 1968 following a period of secondment from Invercargill City Council during the design of the municipal sewage treatment plant for the city of Invercargill. He will continue to work in the Christchurch office.

To see moon shot

One of the firms senior partners, D. LEICESTER STEVEN, B.E., C.Eng., F.N.Z.I.E., M.ASCE., M.I.C.E., is at present on a ten-week world tour investigating current overseas public health techniques with particular referenc to pollution control plants in which treatment tchniques not at present in use in New Zealand are in operation.

His trip will take him through Australia, Asia, Europe and the United States of America. While in the United Kingdom, he will attend the annual general meeting of the Institution of Civil Engineers, being a member of the New Zealand Advisory Committee of the Institution.

As a director of New Zealand Newspapers Ltd., he has been accredited press representative facilities to view the Apollo moon shot at Cape Kennedy in July.

H. Elder

M. G. LATTA

Friends throughout the electricity supply industry would have been saddened to hear of the sudden death recently of Mr M. C. Latta, C.B.E., A.S.C.E., F.I.E.E., former chief engineer of the New Zealand Electricity Department.

Born in Invercargill in 1903, and educated at Balclutha District High School and Canterbury University, he commenced work with the Public Works Department (hydro-electric branch) on 3 December 1923 in the Hamilton district.

He was continuously employed in the Public Service on electrical engineering work until his retirement in December 1963.

He was appointed to the permanent staff in 1925 and later spent two-and-a-half years overseas in the United States, Great Britain and Sweden, studying and gaining experience, particularly in the field of protective relaying.

After his return in 1929 he was appointed to Head Office so that advantage could be taken of the specialised knowledge he had acquired overseas, being responsible for the supervision of the installation, testing, maintenance, and operation of relay systems throughout the country, in addition to carrying out general system calculations.

From 1941 he was responsible for the correlation and supervision of all design activities, including the design of the New Zealand 220 kV transmission system. In 1940 he was appointed chief engineer of the then State Hydro-electric Department (now New Zealand Electricity Department). In this position he was responsible for all the department's engineering work in the planning, design, construction, and operation of the state electricity generation and transmission network.

He was responsible for inter-connecting the separate North and South Island networks and undertook the design and construction of the inter-connecting link by direct current transmission of power over the 500 kV line from Benmore power station, and associated submarine cables across Cook Strait to Haywards, commissioned early in 1965.

This 500 kV d.c. transmission system was a leader in world practice and still attracts intense international interest. Discussions arising from this world-wide interest show the very high regard in which Mr Latta's courageous pioneering work is held in many countries.

He is survived by his wife, a former president and a life member of the Wellington Victoria League and daughters Diane and Susan.

SITUATION WANTED

METALLURGICAL ENGINEER

Metallurgist with 10 years' experience (B.S., M.S., Ph.C., age 32) desires industrial or teaching position in South Island. Areas of competence include metal fatigue, laboratory techniques, alloy development, and protective coatings. Will arrive in N.Z. November 1971 from U.S.

Reply to:

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P.O. Box 3047,
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(Distribution)

The Horowhenua Electric Power Board invites applications for the above position.

Applicants should hold a University degree in Electrical Engineering, or be a Corporate member of the Institution of Electrical Engineers and preferably be a registered Engineer.

The commencing salary will be in the range of $5,500 to $6,500 per annum and will we reviewed annually.

Applications will close at 4 p.m. on Thursday, 30 September 1971.

For conditions of appointment and schedule of duties please apply to:

THE STAFF CLERK,
P.O. Box 244, Telephone 6119,
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The rates for these advertisements are $5.00 per s.c. inch, $35.00 per quarter page and $63.00 per half page.

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DESIGN ENGINEER for senior position; applicants should be registered and should be capable of complete co-ordination and design of major commercial and multi-storey building projects.

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Phone: 48-914.

DESIGN ENGINEER

The Otago Harbour Board, Dunedin, New Zealand, requires URGENTLY the services of a suitably qualified

DESIGN ENGINEER

Cellular container ship services commence from the port in June 1971, and the board has development plans for a large-scale container terminal complex.

The position is an interesting and challenging one and initially involves detailed design work for a new container wharf.

A commencing salary of up to $NZ7,500 p.a. is offered, with prospect of further advancement.

Applications close with the Secretary, Otago Harbour Board, P.O. Box 1, Dunedin, on 10 August 1971.

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I. A. McCUTCHEON,
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Those N.Z.I.E. members who are considering applying for positions advertised by local bodies are reminded that the Institution has a standard set of conditions of appointment, and that, if conditions relating to any advertised position appear to affect engineers unjustly, such conditions should be immediately referred to the Institution for scrutiny.