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Engineering Archive - Preservation and Prospects.

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In Memoriam: BRUCE R. GAMBLE: 1942 -2004.

***SUMMARY**: Strategies for collecting, conserving, discussing and making available Engineering Archive are reviewed. Because the field for collecting is so wide, categories need to be identified. The category of books and papers, such as letters, plans, and similar, is a primary interest here. The internet has to some extent replaced conventional books and papers for everyday use and reference. In archival terms this has strengthened the case for wishing and needing to value and conserve the books and papers from the pre-internet era. This need will continue into the future even if the on-line coverage and content continues to expand in unexpected ways. Educational initiatives are also discussed for promoting the preservation of engineering heritage. These initiatives could also complement the aims of the IPENZ Foundation in the future.*

Keywords: Biographical archive, educational opportunities, engineering archive, personal archive, provenance, public domain.

1. INTRODUCTION.

This paper can be regarded as a sequel to an earlier paper, [**1**], presented in Dunedin at the IPENZ annual conference twenty years ago. We shall adopt a definition for 'engineering archive' as being: essentially any materials, be they hard copy or electronic, which relate to engineering in the broadest sense. This is potentially a very wide spectrum of materials. What is in practice collected will depend upon availability and the scope to provide secure storage and preservation regimes. Clearly in practice there is a very severe limit on storage and preservation facilities. There are also selection criteria to be agreed upon. And this is in an ideal world in which there is access to potentially important material. Framing a comprehensive policy for collection of heritage material is not a well defined task. There is considerable scope for preferences to be expressed. The priority material of most interest to this writer is biographical archive. This is a small subgroup of the whole field. A special feature of this type of archive is that much of the most interesting and relevant material may be held privately. Then arises the question of how the material is identified as existing, then how it might be assessed and, if thought to be of sufficient importance, how to acquire the material for a collection associated with the profession, to be held by the Institution, or in a public library or other accessible venue.

The companion paper,[**1**], was written at a time when major changes and upheavals were occurring in our countries and in particular, in the employment regimes for engineers. Government owned entities, such as the Ministry of Works in New Zealand, and other similar repositories of engineering expertise, were being privatized. The rapid change saw much engineering archive changing hands, sections of it passing out of the public domain and some just being destroyed! In the last twenty years there has also been the ever growing mass of on-line archive materials. Most of the discussion here will refer to New Zealand conditions, with some references to Australia when the author feels comfortable to make them. First we shall review outcomes from some of the earlier changes, before going on to discuss the future for engineering archive in the current social and economic environment. We also venture some discussion of what amount to policy matters. This is an attempt at bringing the heritage topics in a general way into the mainstream teaching environment of the B.E. degree. There is potential to ally cultural and technical considerations in a more integrated manner. A future best-case scenario could be a profession better informed on cultural and technical issues, and the interplay between them.

2. RESUME OF THE 1980'S CHANGES.

Paper [**1**] drew attention to the likely fate of important publicly owned engineering archive. Some important documentary collections, such as those within the then MOW, have been lost to the public domain. The Copyright Act, as an agency in archive collection growth, was also discussed in [**1**]. Since then the Act has been revised. The changes made were largely driven by the publishers and the trade and not the community at large. As a result, New Zealand is out of step, and behind, in the application of Deposit Rules for publications, and the role that such rules play in collection formation and growth. Other unanticipated changes and disposals have also occurred - for example a significant disposal of technological materials was made by the Royal Society of New Zealand from their library in the late 1980's. Details of the materials culled from their collection are not on the public record but some of the disposals can be reconstructed from the various items that appeared on the market at the time. A typical example of a disposal is the book, '*A Treatise on Natural Philosophy*', Part 1, by W. Thomson (later Lord Kelvin) and P.G.Tait,Oxford,1867. The title '... *Natural Philosophy*' reflects the circumstance that both authors were Scottish academics. This book was one of the most influential and valuable works on mechanics in English in the nineteenth century. The copy disposed of was a first printing and of special interest as a result. It may have been unique in the NZ library system. In addition to the Thomson and Tait, several other scientific classics and early New Zealand items were disposed of. One such classic was a first edition of J. Clerk Maxwell's '*Electricity and Magnetism*' of 1873. This work is of comparable importance to a first edition of

Newton's 'Principia..' of 1687. A NZ item sold at the same time from the Royal Society Library was the Hockstetter Atlas of 1864. This includes detailed maps of the Pink and White Terraces before their destruction in the Tarawera Eruption. We shall return to the library sphere and collection policies later.

One emphasis here will be on biographical and especially personal archive. It was observed in the 1989 paper,[**1],** that this is probably one of the most vulnerable forms of archive in our social fabric, and not just in the engineering sphere. Sometimes important archive may be safely housed in a public domain location, possibly during the owner's lifetime. But at least as often, this is not the case, and the fate of the material is probably decided by family members who are only vaguely aware of the potential importance of the materials. Combine this with the other pressures and duties falling to the family members at the time of a parent's death and it is not hard to visualize the scope for important materials to be lost.

In both Australia and New Zealand several very valuable public domain library collections have been received as bequests. In several cases these important, personally assembled, collections have become essentially the core collections of State and National libraries. Their emphases differ according to the particular interests of the donors but in general they embrace a wide range of subjects. Many of the great libraries around the world have benefitted, and continue to do so, from the copyright provisions of the particular country. This was a point brought up in the earlier paper[**1**]. New Zealand lags in this regard. General cultural materials usually form the core of these collections. Most have very limited holdings of engineering or technology materials. The importance of these early collections cannot be over estimated due to their deposit in the public domain. In Dunedin there is the Hocken collection. Other nationally important New Zealand collections are the Turnbull collection, which forms the core of the research library within the National Library in Wellington, and the Grey collection in the Auckland Public Library. It is relevant to note that Grey, during a long and varied lifetime, corresponded with several of his contemporaries, several of whom were pioneers in the sciences and technology. As a result there are what are now especially valuable copies of his correspondents' works to be found in the Grey collection. In Australia there are world class collections such as the Mitchell and Dixson in Sydney, and others interstate.

To conclude on the 1980's changes, undoubtedly much in engineering archive terms has passed out of the public domain, and this must be regretted. How much of potential longer term importance has actually been *destroyed* as the result of the changes at that time it is probably impossible to estimate in any sort of useful manner. Library deposit is likely to feature prominently in any future active archive collection policy by the engineering profession. The location and resources available for secure, long-term preservation become important. National libraries, and official Archives, no doubt have a role to perform for housing some categories of engineering archive. In the present circumstances engineering and technology archives are not priority materials in national collection development terms. The profession therefore needs to have a policy and proceed to collect according to that policy. Part of any policy must include housing a collection and identifying resources to maintain it.

There are exceptions to most rules and this is true for some national Library collections and their hunger for particular engineering archive. In the case of Sydney two high profile engineering feats are enduring subjects of interest to libraries and librarians - namely the Opera House and the Bridge. The Opera House and the constant references to its past and present ensure continued public interest. The Bridge runs a close second.

3. THE PRESENT SITUATION.

There has been a long held view in the profession that engineers and engineering are undervalued in society at large. We engineers, among the professions, are not alone in holding such a view of our profession. Archive of importance in some general sense is in a tenuous way linked to personal and collective prestige and acceptance in society. Engineers and engineering are largely creations of the Industrial Revolution. Paradoxically the case could be made that an emerging profession is best able to catch the public imagination in the early rather than the later, mature years of the process. For the Western world, and especially the English speaking world, the mid nineteenth century was the high point for the engineer and engineering being at the forefront of public awareness. The Scottish medic-turned-author, Samuel Smiles (1812-1904), published the first of his volumes of the 'Lives of the Engineers' in 1857. Eventually five volumes were produced. These were popular works and remained in print for half a century. Indeed they remain in print in an abridged form.

Smiles was an observer of social issues. His lifetime spanned the period of rapid and often very difficult social changes, brought about by the very rapid changes associated with industrialization. Engineers played a civilizing role in these changes in Smiles' view. We would probably all agree with him, and then go on to expect the role for the engineer might be seen as the same today. But this does not appear to be the case, at least not in the public perception. Why is this so, if it is so? Darwin published his great 'On the Origin of Species' in 1859, as we are currently being reminded. He shared the same publisher as Smiles, John Murray, whose publishing house went on to become a dominant science and technology publisher. Darwin's influence has taken many twists and turns to get to the present pre-eminent position. His work was far less read at the time than were the Smiles books. Darwin's is an easily recognizable name in modern society, but few engineers, if any, are in the same league! An exception might be Brunel: perhaps paradoxically, Smiles did not include him in his 'Lives..' volumes. Has our day passed for recognition? Personally, I don't think it has. On the other hand there are some missing elements in the recognition picture. Paucity of engineering-related archives, in a general sense, is one of the missing elements!

Often the most highly regarded of history texts can be searched in vain for references to engineers as individuals, whereas politicians and others of the time are named and their activities are described in the unfolding history. There are no doubt many reasons for this circumstance. If the event being referred to is being written about by an observer such as an historian, then the probability is that many sources are referred to prior to the account being

written. In broad terms the engineers are frequently not identified even though the products of their expertise are the subject of the writing. Some of the reasons for this omission are that the primary records from which other compilations are made are not specific about the personnel who created the original infrastructure. This anonymity aspect may then be layered with other relevant records and has contributed to the engineer's low profile. One remedy would be to better document authorship. This should then lead to a situation where personal archive becomes easier to accumulate, and only then can it be preserved, if this is the decision later. It would be interesting to know, for example, how many of us attending this conference are regular keepers of a personal diary! This is the most individual form of personal archive and is the basis of much of the most reliable knowledge about individuals in historical terms. Taking the argument in a slightly different direction, it could be argued that diary keeping should be urged upon the young engineer as an important professional as well as a personal discipline. Whatever our personal inclinations and habits, it is a matter of observation that reliable biographical information, for engineers as a social group, is often difficult to obtain. This brings us to consider how others view us as a profession, and what we can learn from this.

4. ENGINEERING ARCHIVE - BIOGRAPHICAL.

For present purposes '*Engineering Archive*' is being regarded as any aspect of an engineering structure or end product. This leaves us with all facets of planning, design, construction and operation, and very importantly, archive relating to the personnel involved. Elsewhere [**2**] the national collections of biographical archive are discussed. The nearest to home for us are the Australian Dictionary of Biography (ADB) and the Dictionary of New Zealand Biography (DNZB). Both these publications are modeled in many respects on the UK Dictionary of National Biography (DNB). The original DNB was a 60 + volume work. It was first published in the last quarter of the nineteenth century, from 1885 till 1900. Several supplements were issued subsequently. This was a mammoth task. The key editor of the DNB was the literary figure, Leslie Stephen, Virginia Woolf's father.

Over the last twenty years this whole corpus of biographical information has been reviewed and was recently greatly expanded and brought up to date. The new version is now known as the Oxford Dictionary of National Biography, the ODNB. There is both a print and an on-line version. There is also a policy of regular, continual, ongoing updating. Apart from the individual's merit to be included in the dictionary, as perceived by the dictionary editor(s) of the time, the key editorial policy common to all three dictionaries is that the individual to be included must be dead! All three publications adopt the format that all essays are signed by their authors. The source materials used to write an essay, or revise in the case of the ODNB, form part of the essay.

There are significant differences in editorial policy evident across these three prestigious publications. The ODNB and ADB include more personal archive on their subjects, for example their probate details, than does the DNZB. On the other hand the DNZB has a much more liberal policy in the choice of subjects - more the 'worthy', and even 'notorious', rather than 'celebrity' subjects have featured in DNZB than in ODNB and ADB. But when it comes to looking at the results of these various editorial policies it seems that engineers along with some other professional groups are more sparingly represented in the DNZB than in either of the other dictionaries. (One entry in the ADB that does not appear to follow the 'rules' is the essay on Azaria Chamberlain - the nine-week old baby who disappeared in the outback in 1980.)

Similar observations to the above have been made elsewhere [**2**], and some reasons have been advanced for the differences. Unfortunately, the single most canvassed reason for the paucity of engineers in the DNZB is said to be because there is too little, reliable biographical data available for a suitable essay to be written on the individual. This situation has improved in recent years. There have been initiatives taken to accumulate bio-data, including taped interviews, from Institution members during their lifetimes. How this data will be disseminated is still under discussion. The manner in which Privacy Laws are administered may also make it more difficult in the future to trace the careers of individuals.

These differences in editorial policy have led to a situation, at least where engineers and technical people are concerned, where if the individual has pursued a career outside of their birth country there is little prospect of their being included in the DNZB. Contrast this with ADB policy, as seen from the resulting volumes, where even if an individual spent only a brief time in Australia but has caught the eye of an editor, they have been included in the ADB. Two examples illustrate the point - William Hudson and Clifford Dalton. Both were NZ born, neither is included in the DNZB. Both are included in the ADB. In Dalton's case he resided in Australia for only a few years. The reason for his inclusion is no doubt because of the key postings he held in that brief time. Sir William Hudson's inclusion is no surprise, given his many years of service in his adopted country and the distinguished contribution he made. Other examples of expatriates in related fields to engineering who have been passed over by the DNZB are Leslie Comrie, a pioneer numerical analyst of world standing in the emerging field of large scale computing and what has evolved into IT, and Alexander Aitken, a very distinguished mathematician. The ADB on the other hand has lengthy essays on many expatriates, for example Howard Florey, whose careers were spent entirely outside of Australia. With a cap on available space in works of this kind it is not surprising that some worthy individuals are not included. This is especially true of the DNZB since there is no policy in place to up-date or extend the set of five volumes which were published during the 1990's. The ADB currently runs to about seventeen volumes, with others in active preparation.

Another publication we need to refer to in the present context is the *New Zealand National Bibliography (NZNB)*. This five volume work, bound as six books (Volume One extends to two Parts in two volumes) was designed to gather together all relevant bibliographical information on New Zealand publications. As can be imagined, such an enterprise was a huge task. The Editor and Principal Compiler for all the volumes was A. G.(Graham) Bagnall (1912 - 1986). He was probably the most distinguished NZ bibliographer of his time. During the years of compilation of the NZNB Bagnall was the Turnbull Librarian in the National Library, Wellington. This amounts to his being the

chief research librarian. The brief was to cover the period from the earliest times until 1960. The whole period was divided into two sub-periods: earliest times till 1889, then 1890 to 1960. The first volume was published in 1969, being Vol.2 covering A-H of the period 1890-1960. Then followed Vol.3 I-O in 1974 and Vol.4 P-Z in 1975. Volume 1 (in two books) followed in 1980, and the series was completed with Vol.5, Supplement and Index, in 1985. The Editor was by then more than ten years into retirement. He died the following year.

When we refer to these volumes today, the erudition of the compilers' is very evident. The series is an extremely valuable national resource. This is not to say, however, that it does not have areas of omission. This writer cannot comment on the completeness of the coverage for the literature and social sciences and arts generally. But the work clearly does not pretend to cover engineering and technology in any comprehensive way. On the face of it this seems somewhat paradoxical. Some areas of technology are apparently covered in some detail. These are mostly related to farming practices, and the supporting sciences such as botany.

There are some non-literary categories that feature: for example, mathematics. D.M.Y. Somerville (1879-1934) and H.G.Forder(1889-1981), both distinguished academics who occupied the mathematics chairs at Victoria and Auckland University Colleges for decades. Their several publications, including some published before they arrived in NZ, are listed. But several other mathematician's works are not. Recall, too, that importance is not a criterion for inclusion. The physicist Ernest (Lord) Rutherford's books are listed, but the Dunedin alumnus, Joseph Mellor's more numerous and very distinguished chemistry volumes are not. Let us consider engineers, NZ by birth and/or working in the country, and publishing. Mining engineer James Park's texts are listed, but A.M. Hamilton's papers on his WW2 bridging system are not, even though they fall well within the time period. Hamilton's book about his experiences as an engineer in Iraqi Kurdistan between the wars is listed, but without a reference number, possibly indicating it was a last minute addition. Of more importance for engineers in the future, who might expect to obtain some guidance from the NZNB, there is no reference to the *Proceedings* of the NZ Society of Civil Engineers, as the Institution was titled until 1939, and where many valuable technical papers were published. Even given the exclusion of periodicals it seems odd that no reference to the content of the volumes is made. These pleasant to handle, quarto-size volumes contain a unique archive of close to forty years of engineering endeavour in NZ. Current IPENZ publications policy is not producing comparable technically competent papers and descriptions of works as was achieved by the *Proceedings* in the period 1914 to 1951. By 1951 '*NZ Engineering'* had become established as the Profession's publication vehicle, despite the private ownership structure that had been adopted. In its turn, *NZE* proved to be a worthy publication and itself is the primary reference for all matters relating to the professional engineering of the day. The change of ownership and format in the 1990's and the later change of format for Annual Conference and publication of their technical programme and papers, has greatly weakened the chain of creation of contemporary NZ engineering technical archive. Because of the vicissitudes of the engineering library holdings in NZ over the years it is possible that there are fewer than possibly three or four complete runs of the *Proceedings* volumes on any shelves, anywhere. This makes them an endangered species! Given this scarcity, a useful project would be to summarise the contents under a variety of headings and draw attention to the excellent and important papers by authors, such as Arthur Mead, and the city water supply and environmental conservation work that he and others largely pioneered.

To illustrate the fragility of the engineering bibliographic content in the NZNB consider the entry for S. I. Crookes in Vol.2., covering items C1787- C1791. Crookes' dates are given as 1871-1955. These describe electrical engineer Samuel Irwin Crookes, **senior**. He was President of the NZ Soc. Civil Eng. in the year they decided to embrace all engineers, not just Civil in the name, and became NZIE, in 1938-9. None of the references quoted are by this Crookes. Apart from a 4p report (C1788) based on data supplied by this Crookes, all the other items were written by his son, S.I. Crookes,**Junior**(1896-1983),[**2**], who was a structural engineering academic and an almost forgotten pioneer in the field of earthquake engineering. There is no reference to SIC Jnr. in the NZNB or any of the other biographical collections referred to above.

From what has been described here, and elsewhere in this paper, there is clearly ample scope to map out plans to fill the many gaps that there are in the public record so far as the profession and the professionals are concerned. One possible reason for the lack of inclusion of any mention of the *Proceedings* in the NZNB is that the unenthusiastic remarks Newnham makes about the quality of the early *Proceedings* in LSA(see below), at p.336 for example, were read by, or known to, Graham Bagnall when he was working on the compiling of the NZNB. Indeed it would be interesting to know whether the two men were known to one another. One future scenario could be to prepare what amounts to the copy needed to fill the major gaps that the engineering profession might see in the NZNB as it relates to engineering and technology publications. The worst case outcome of this would be if the National Library took no interest in the material. A next step then might be for the Institution to incorporate these bibliographical materials into a centennial history of the Institution, sometime on or after 2014.

The accessible biographical archive relating to engineers working in NZ during the early period of European settlement is almost entirely confined to the pages of F. W. Furkert's (1876-1949) 'Early NZ Engineers'(ENZE),[**3**]. This was published in 1954, some five years after Furkert's death. The circumstances at the time required that the manuscript be further edited before publication. This was undertaken by his successor and colleague, W. L. Newnham (1888-1974). (*WLN shared the same birthday as FWF, and was twelve years younger.*). There are no references provided in ENZE. But there is mention of Furkert's preliminary working manuscript materials, which passed to Newnham. We can presume these would have included references to sources. What appears to be lost are all these preliminary materials on which the book is based. What became of these materials seems to be unknown. It is safe to assume that these papers would have been a valuable archive for any future project to take up where Furkert's biographies terminated, at engineers whose birth year was before 1867.

Another book, which in some respects carries the Furkert work further, is Newnham's 'Learning, Service and Achievement', ('LSA'), [**4**], published by the NZIE in 1971. This was intended as a history of the Institution from the foundation in 1914 as the NZ Society of Civil Engineers until 1964, fifty years on. There is thus a gap between the end of Furkert and the start of Newnham, of about forty years until the First World War. This is a simplification of the comparison. 'LSA' is more a history than a biographical work though it does contain useful biographical notes, including about Furkert. If references to a work are a usefulness indicator, then the impression is that 'LSA' is not much appreciated judging by the sparse references to it. But we would have a much poorer knowledge base of the Institution and engineering in New Zealand if this work had not been commissioned. Ironically, Newnham, after being Furkert's editor, found himself unable to finish the LSA work he had began. Newnham was the editor of a series of commissioned essays though we do not know the authors of any of the component parts. A further editor was appointed and he brought the book to a conclusion and eventual publication, some seven years after the intended date. Fortunately for the profession that second editor was himself both an engineer and a writer/publisher: F. N. (Nigel) Stace (1915-2001), the then editor/owner of the journal, '*NZ Engineering*'. For reasons that Newnham says in his preface were related to the editing role he occupied, he took the decision to delete all the names of the authors of the individual chapters. This seems a drastic step and one that probably cannot now be retraced, since it appears that in this case too, all the preliminary drafts and associated papers have not survived. This is unfortunate and as a policy, hopefully will never be repeated. A sign that there may have been haste to complete the task could account for a mis-spelling in the title on the upper board of the binding. It is likely that Furkert and possibly Newnham made use of the materials contained in the several provincial 'Cyclopedia' volumes that appeared in the late nineteenth century. Valuable they are but a little caution needs to be exercised when using these sources since they were assembled from materials authors submitted to the publisher after paying a fee for inclusion of their material. With the centennial of the Institution in about five years, now would be an appropriate time to consider the scope to write a centennial history!

What is clear is that there is ample scope for further studies of the early engineers who were active in NZ, especially in the period c1880 to 1914. This was when much of the railway expansion was occurring, along with the opening of the North Island Main Trunk rail line, and with continued growth of the towns and cities, roading and other infrastructure. It would be a task not to be entered into lightly, but as a worthwhile venture a companion volume to the Furkert and Newnham books should be facilitated by the profession. A preference would be to have such works, if not wholly written by, at least edited by an engineer. This may be difficult to achieve, especially in the current environment where the NZ Profession's only regular in-house publication, eNZ, is composed of articles commissioned from journalists. A section of the professional membership is retired. Their proportion of the whole membership is likely to grow in the years ahead. There is a case for harnessing their knowledge and writing skills to provide suitable copy, especially in progressing any successor volume to the Furkert and Newnham volumes, or of a centennial history of the Institution. The authors of any published materials should be identified in the same manner as is the editorial policy of all three of the Biographical dictionaries discussed above.

Beginning in 1908, editions of *A Who's Who in New Zealand.*. have been published at irregular intervals. About fourteen editions have been published thus far. The editor for the early editions was G.(Guy) H. Scholefield (1877-1963). A newspaper editor and historian, GHS also wrote the first (two volume) DNZB, Wellington, 1940. The particular virtue of a Who's Who.. is that the biographical information is provided by the subjects themselves, but only at the editor's invitation. In stark contrast to Dictionaries of Biography, the Who'sWho consists exclusively of *living* subjects. There are several very interesting and valuable mini self-portraits of engineers in this now century old publication.

5. ASSOCIATION COPIES.

In addition to archive of the type we are advocating should be sought and preserved in accessible collections, other facets of career and the achievements of engineers can be gleaned from association copies of works of importance, most especially books, known to have been owned and/or used by engineers of the period. These might be copies of documents or books authored by the particular engineer, or more often are likely to be other materials which are known to have been in their possession. How much they may have used such materials is another, and probably unanswerable, question. For example, when we come to ask how a particular engineer may have sought to acquire particular skills, are there available in national collections books and other materials which the individual owned or is known to have studied from? In the 1930's there were developments in structural analysis in the USA, the UK and elsewhere that were capable of supplying reliable numerical results for the actions generated by loads acting on indeterminate frameworks. Earlier there had been developed methods for indeterminate analyses that required equation solution rather than iterative methods of solution, for example the energy theorems of Alberto Castigliano (1847-1884). Whatever the method employed, long before the advent of computers, the humble slide-rule and, if need be, tables of logarithms, were about the only computational aids available. Methods of problem formulation capable of describing the increasing use of rigid concrete frame construction, required new insights and more detailed and powerful methods were being sought. One of these was the Hardy Cross method employing an iterative solution, known as Moment Distribution. Pre-WW2 the Auckland office of the consulting engineers Jones and Adams produced designs for building structures in concrete and may have had need to get abreast of these latest methods. At least the personnel did have access to a copy of Cross's 1932 published book, with Morgan, titled 'Continuous Frames of Reinforced Concrete', because Jones' copy survives. It is signed 'Stanley W. Jones, 1939'. Judging by the condition, it had been referred to on many occasions. American engineers of the period favoured rigid concrete arches for many medium sized bridge structures and Cross devotes considerable space to their analysis. Jones and Adams designed several concrete arch bridges across the Waikato and other sites, especially after WW2.

In the same building, Smiths' Building in Albert Street, Auckland, was the consulting practice of Gray and Gulliver, later to become Gray and Watts after Gulliver's death in c. 1939. Did W.A.(Arthur) Gray (1889-1953),[**2],** decorated , wounded and a Prisoner of War in World War One, who was the main and very able designer in the practice, have need for, or access to, such an aid as the Cross and Morgan book? The iconic Auckland War Memorial Museum, with concrete casings of the structural steel frame and floors, and Portland stone clad facade, was built to the structural designs by Gray. But it had been completed before the appearance of the Cross and Morgan book. In passing it could be noted that Gray's contribution to the project is not acknowledged on the dedicatory plaque on the building, [**2**]. About the time that Gray died, the highly innovative tubular steel space-frame structure for the new Members' stand at the Auckland Racing Club's Ellerslie racecourse was in preliminary stages of design. Gray's partner, and nephew, Lawrence (Larry) B. Watts (1908-1966) was the principal in the practice who saw the project to completion. Watts, a very able designer in the Gray mould, had gained foreign work experience after graduating from Canterbury before WW2. The engineer primarily responsible for the analysis was Harold E. Wallace (c.1907- c.1991), a well qualified Maori engineer, who had been teaching structural analysis at the Auckland School of Engineering at Ardmore, before joining the Gray, Watts and, by then, Beca practice in the mid 1950's. Later he joined the staff of the Architecture School, and remained there until he retired. As it happens, the basic tubular structure for the Ellerslie stand was considered to be determinate, with some allowance made for joint rigidity. So computation, though lengthy and tedious, did not need to draw upon Cross's methods. Nevertheless it would be interesting to establish whether their office had a shelf of books, perhaps including C & M, and which were the most heavily used items! The Jones and Adams partnership evolved into Jones, Adams and Kingston, and then into Kingston, Reynolds, Thom and Allardice. In retirement, Ian Reynolds spent much time and effort researching the history of the practice. This writer has not seen the results of his efforts. They are undoubtedly valuable.

Energy methods played a substantial role in post WW2 structural analysis teaching. The Castigliano energy theorems were about eighty years old at that stage. They became known in the English-speaking world through the translation of Castigliano's 1879 book from the Italian original into English by Ewart S. Andrews, a London-based consulting engineer and academic, in 1919. Andrews was himself the author of several well regarded books, covering structural analysis, strength of materials and reinforced concrete (RC) construction, in the early years of the twentieth century. One of his books on RC construction, published in 1912, and owned by E.J.R.McLaren, an early staff member in the Auckland Engineering Department, survives. This copy is signed but not dated. It is annotated and has been well used.

We are all made different and often value a particular artifact very differently. Personal experience has been that associations of the type described above are not always seen as relevant or of value. When the person making such a judgement is the head librarian in an important library then the scope for advancing the cause of (engineering) archive is made that much more difficult. Such a situation has arisen in the writer's experience. A book collection, part of which could have been of potentially archive quality, was acquired by the particular library. The instruction went out that all ownership marks in the books were to be erased. This goes to the heart of archive collecting practice! Provenance, that is previous history of ownership, can be a vital tool in the study of archive. To have this information obliterated from books (or other materials) given to or acquired by a library is, in this writer's view, a form of vandalism, and a reason for hoping that collections do not fall into hands that do not value the association!

A known association copy of a work of importance is the copy of Rankine's 'A Manual of Civil Engineering, 8th Edition, Glasgow 1872', with ownership documentation extending back to the original owner. On the title page, in a clear hand, is 'E. G. H. Mainwaring, Christchurch, Feb. 1873'. The 8th edition was the last revised by the author. Rankine died on Christmas eve 1872, just months after completing the revision. This important text-book, first published in 1862, remained in print until well into the twentieth century and continued to be revised at regular intervals and long after Rankine's death. Of all the sources of education and instruction available to the young professional engineer, in the period 1858 to 1900 especially, one or more of Rankine's several 'Manuals', on Applied Mechanics (1858), The Steam Engine...(1859), Civil Engineering (1862), and Machinery and Mill Work (1869), is likely to have been a primary component. These 'Manual(s) of..' were each major works. They were typically of 600 pages or more, and in their day were expensive. The '*Civil Engineering*' was the most expensive and remained at the price of 16/- (16 shillings) into the twentieth century, despite the severe economic depression and deflation in the 1890's. Topics such as Rankine's well known studies of theoretical soil mechanics, the active and passive states, deformation patterns and the like, are dealt with in both his '*Applied Mechanics*' and in '*Civil Engineering*' for good measure. Just what role books such as these played in the education of the young engineers, and may be also of mature engineers, has not been studied in any systematic way. Having association copies is a start in the study of their influence on the profession. Mainwaring is not included in Furkert,[**3**], and it seems little is known about him. However he is shown seated in the front row in a 1901 group photograph of senior NZ railways personnel, in the Railways Gazette, Vol 1 1926. Mainwaring may have become a qualified engineer. What we do know is that he was appointed to the newly created senior post of Railways Land Officer in 1880, a post he still occupied in 1901. By 1926 this copy of Rankine's CE was in the possession of A.R. Callander (d.1950), a licensed surveyor and civil engineer, then of Levin, and later of Christchurch. His son, R (Bob) A. Callander (1925-2007), who possessed the Rankine copy for many years, retired from the Auckland Engineering School staff, after a varied and very productive career, about 1988.

Another association copy, J.J.C.Bradfield's copy of a later edition of Rankine's '*A Manual of Civil Engineering*', was probably bought new by him and is now in the rare books collection of the Fisher Library at Sydney University, [**5**]. The edition and ownership marks are consistent with the book being acquired by Bradfield when a student in the then relatively new Engineering faculty in the University of Sydney. Bradfield (1867-1943) had migrated from Queensland to study at Sydney University since

engineering was not a course of study available in his home State at that time.

Provenance - ownership history - should be a highly prized adjunct to the materials themselves. It is especially so in the world of literature. The suggestion is that we as engineers need to give much more consideration to preservation of such information if we are to be taken seriously by other sections of society when it comes to understanding and valuing heritage matters. A.R.Callander, from earlier in this Section, purchased new, at intervals, the three volumes of F.G.Royal-Dawson's pioneering books on roading: alignment , curve design and multi lane highways. These accounts were published by R-D after he had retired from a busy professional life in the Indian Railways and as a Professor in the newly established University in Cairo. These were the formative years of the technology. The volumes were published in 1932, 1936 and 1938, respectively. The texts introduced many new features to English language readers, such as lemniscate shaped road curves to enhance road safety as vehicle speeds increased. ARC was evidently wishing to be well informed about cutting-edge road engineering. The final volume considered multi-lane motorways and the use of flyovers to separate crossing traffic streams. This was almost the equivalent perhaps of 'spaceage' infrastructure at that time. Some Italian Autostrada's and German Autobahn's were built in the 1930's. ARC's three R-D volumes survive. They have clear ownership marks and dates to clinch his having purchased them new. The subject matter, especially of Volume 3, describes some roading types that did not exist in New Zealand at the time. We should remind ourselves that for some years after WW2 there was no fully sealed road from Wellington to Auckland via Taupo: there remained several long stretches of shingle covered, unsealed carriageway. Motorways of the type considered by Royal-Dawson (b.1867-) were still about a generation away into the future for most countries. Bought new the purchase price of the first volume was 12/6d. This compares with the daily pay rate of 7/6d for a married NZ Trooper on active service during WW2. The conclusion drawn is that such books were expensive.

There are also other types of media in relation to archives, besides books and 'hard copy' of various sorts. Sound recordings of conversations with engineers, most often made when the subject was in retirement, offer another perspective on the engineer and his/her/self, [**6**]. Photographs of works and portraits of individual engineers, as traditional likenesses, or photographs, are also an attractive and informative media. Not all the relevant portraits maybe available for display in public collections, except for special events, but knowledge of a portrait's existence and whereabouts is itself important information. The IPENZ website is a growing resource and will no doubt become more important in the future.

6. SOME SPECIAL CASES.

Special status might attach to particular individuals. Three related examples of engineers in this category are New Zealanders John Britten (1950-1995), Bruce McLaren (1937-1970), and A. G. (George) M. Michell (1870-1959), to take an Australian example. Their individual successes are quite well documented, mostly on the internet, but there is always more that can usefully be added before the personal memories become too vague. Britten is probably the least well known of the three. On 11th February 1995, a few months before his death, he was invested with Honorary Fellowship of IPENZ at the IPENZ Annual Conference, held in Palmerston North that year. McLaren, the GP racing car driver and very successful constructor of F1 and Cam-Am cars, has had little, possibly no, recognition from IPENZ. Michell on the other hand is regularly commemorated when the Michell Medal, one of the premier I. E. Aust awards, is made despite AGMM's resolve in his lifetime to decline Institution membership.

It is Britten's near singlehanded pursuit of a dream-like goal for motorcycle race competition success, as a designer and constructor, that we remember him for. It would be of interest and relevance to know whether Britten was himself influenced by McLaren's earlier success as a competition car constructor!

McLaren started his engineering studies at Auckland University but did not complete them. His motor racing successes began when he was still in his teens. McLaren was mentored by Jack Brabham into the Cooper Cars works team and, despite a degree of physical disability, he very quickly progressed to the world stage. He became the youngest ever winner of a F1 race to that time. This was in the first post WW2 US Grand Prix F1 race at Sebring in 1959. He was aged 22. This race also sealed Brabham's first World Driver's title. Within a few years, and after following Brabham into founding a team of his own, Team McLaren had success as constructors of F1 and, more spectacularly, Can-Am race cars. Today the F1 team that bears his name is the second oldest, after Ferrari.

Michell was a genuine polymath. Highly trained academically for the time, from the outset of his working career he practised as a consulting civil, hydraulic and mechanical engineer. It was not long before he had spectacular success as an inventor of major technology in the lubrication field. This technology was commercialised very successfully before WW1, primarily through a joint venture in the UK. His technology played a significant role in WW1 naval technical advances. Then, in middle life, he developed his 'crankless' reciprocating internal combustion engine. For about a decade he devoted his considerable skills and resources, full time, to the commercialisation of this engine type. Despite the merits of his invention, success eluded him.

There is active pursuit of archive and preservation by the Bruce McLaren Trust, which has family participation. This relieves IPENZ of some of the need to take an active part. This writer is not well informed about the Britten archive situation. So far as Michell is concerned, it seems agreed that much vital archive has been destroyed. This is a major loss. A good (auto)biographical record is available since Michell wrote his own obituary for the Royal Society of London, of which both he and his elder brother were Fellows. This gives some perspective to the distinguished contributions that they made to academic and practical studies related to engineering. Much that the brothers pioneered has had important technological value. Almost all the hardware, such as experimental engines and the several road vehicles which were fitted with crankless engines, it appears has not survived [**7**]. Given the dominance of the road vehicle in modern society, and knowing something of the long and sustained effort and expense that Michell

expended on his brainchild, it is both strange and regrettable that this should be the outcome. Michell's experiences provide a good illustration of the vicissitudes in the life of a very talented and successful engineer who struck out on his own to convince the motor industry, especially in the USA, to take him seriously. But success, as measured by acceptance, eluded him. This had a profound effect upon him in his declining years. The disappearances of the crankless engined Austin and Buick cars,[**7]**, and other examples of the technology he created, remain as mysteries,[**8**]!

These three engineers have generated special interest by their achievements but they are relatively unknown in the public domain. They are by no means alone. A comprehensive survey, with on-going updating, of member's achievements is a legitimate function for a professional body. Over a period this could lead to publication of biographical and/or historical material highlighting engineering achievements - later versions of Furkert and Newnham you might say. It is the case that the Furkert and Newnham volumes were produced by Institution members when in their retirement. The evidence seems to be that neither work was regarded as especially notable at the time. Today they stand as notable, and valuable. From other observations made in this paper and elsewhere, the profession should probably accord them an even higher category of value. Let us explore in what role active current members might contribute, and from more than just the ranks of the retired, to the conservation of biographical archive in the future.

7. THE PRIORITIES FOR THE PROFESSION - 1.

The priorities for the Profession in the quest to secure the permanence of archive collections, and their availability for use by relevant persons, is a many sided enterprise. Most commonly, libraries or museums are thought of as the primary repositories for archives. This will probably be the pattern in the future also. The internet is a quasi-library of evolving form. But how permanent is material on the websites and how reliable is it? There are no ready answers available. Important and attractive as most aspects of the Internet are, there remains a need to seek, assess and preserve conventional archive materials of most types. In the early years of organised professional institution development in NZ the growth of an in-house library was actively pursued and reported on in their technical journal. In the 1960's the policies of the day brought about the dispersal of that collection. The writer is not well informed about the Australian experience and practice. There is a library maintained at National HQ in Canberra. The I.E.Aust when at Science House in Sydney had a library. It is presumed that this found its way to Canberra. The MOTAT collection in Auckland is a very valuable resource, as are other similar collections elsewhere in NZ and Australia. The case for direct support from IPENZ to such entities is strong. Some IPENZ members have, as individuals, contributed to these collections over the years. A recent growth point is the rising interest in IT related archive, particularly the hardware, early digital computers and software related materials.

A new start has been made to collect a range of archive materials again by IPENZ in Wellington. This is good news and hopefully will result in a useful collection of archive materials in due course. Relevant materials may remain in family possession for long periods. This outcome could be by choice or may arise from understandable indecision and/ or through lack of suitable advice about possible value to the profession. Personal archives may be offered to repositories such as the National Archives. Not all such offers could expect to be accepted. Yet other materials may be accepted by regional libraries. Some desirable materials may be disbursed by public auction or in the trade. From time to time important collections are dispersed. The currently proceeding Macclesfield library book sale of scientific and related subjects in the UK is an example of a little known but very significant collection now being processed through the auction sale route. There are limits on the scope to purchase such a valuable collection for the nation but hopefully this has been considered.

The profession could be expected to have a policy on collection of archive materials. A part of this could include on-going publicity on the institution's website, and in official publications, describing the policy and outlining priorities such as seeking to identify collections of books or other related materials that could be considered desirable for the professional body to acquire. Some of the libraries of the nation's educational institutions, for example those of the engineering schools, do have modest collections of engineering archive. Much of this material has come as bequests and unsolicited gifts. The Architecture Library in Auckland also collects archive, with some over-lapping into engineering. Generally the staffing of these libraries does not extend to appointment of specialist librarians to take care of these collections. If this continues to be the situation, in time this means a deterioration of the holdings, as experience has shown. It should also be appreciated that whole sections of some of these library's holdings of technical works have been disposed of in recent decades. In some measure this has been by sale but destruction has been the fate of much of this class of material. Lack of shelf space and infrequent use of the material have been the primary factors in taking such decisions.

What then is the prospect for building up archive collections and ensuring their security? This is a very difficult question to resolve satisfactorily. Then there are questions about geographical hazard: for example earthquake in New Zealand, and may be bush fires in Australia. A preference this writer has is to consider a dispersed system of libraries equipped to house archive as well as secure housing in the profession's own (regional) offices/meeting places, and with each centre seeking local materials. Maintaining and adding to the existing collections of archive by IPENZ and I.E.Aust. requires resources both of funds and personnel to care for the materials. In the case of IPENZ this is a reversal of the policy adopted about 50 years ago, when the then in-house library and some unknown amount of archive was disposed of. The current membership will no doubt have views on any new policy. In addition there is a sound case for encouraging researching and writing essays on an undefined number of engineers whose very successful working careers are not well documented. Many worthy subjects are easy to identify.

For example, a prominent early engineer who is not in DNZB but is included in Furkert,[**3**], and whose career remains far from fully explored, is Harry Pasley Higginson (1838-1900). His professional experience was gained in

several countries before he came to NZ. Furkert records that Higginson arrived in NZ in 1872 to take up the Superintending Engineer role for Railways and other public works in the South Island, based in Christchurch He remained in this post for about five years and is credited as being the designer of the combined rail and road bridge at the gorge site on the Waimakariri,[**3**,**11**], during this time. This bridge is still in use, though the rail access has been removed. It is one of the finest bridges of its type anywhere. The completion date is given as 1877 [**11**]. We can ask many questions for which at present, it appears, there are no answers available. How and where was it designed, do any working drawings exist, where was it fabricated and what methods were used to erect it ? These are just some of the questions it would be worthwhile to find answers to. It is tempting to expect that sufficient iron founding and fabrication capability was available at the Anderson engineering business in Christchurch at this period. Did they play any part?

The site is relatively remote and would have been difficult to access in the 1870's. The piers are founded in the boulder strewn river bed. The deck is more than 30 m above bed level. Building such a structure would provide many challenges even for us moderns. The piers are worthy of note: they consist of iron segments forming a hollow rectangular shape with semicircular ends, [**11**]. These were probably sunk into the river bed by controlled excavation of the insitu materials inside the assembled segments. As sinking progressed more segments would have been added, and this process continued until an acceptable foundation was achieved. Then the above ground 30+m high hollow pier shaft would be erected in stages as the pier was progressively filled with concrete. A less ambitious but innovative use of wrought iron to fabricate hollow bridge piers to be filled with concrete, was employed on the Whataroa River bridge in South Westland, [**11**]. (A similar method, but applied to building structures, was used by R.J.P.(Pat) Garden at the Burnside Freezing Works near Dunedin post WW2. In the 1990's a NZ Patent, No: 227555, was granted to Uniservices, the commercial arm of Auckland University, for a generalisation of the technology.)

There is no definite link established between the design of the Gorge bridge and Mainwaring's copy of Rankine's 'Civil Engineering' described earlier in Section 5. It is tempting to think however there could be a link since 1873 was when the Rankine copy was purchased new in Christchurch and was also when Higginson, just recently arrived in Christchurch to direct operations in the railway department, would have had the Waimakariri Gorge bridge in his office to be designed. This speculation is being made because the method of pier construction employed on the Gorge bridge is described in some detail by Rankine in his Article 406. There is further elaboration in an Addendum in this particular edition of 'Civil Engineering'. Art.406 also includes a discussion of using compressed air to balance water pressure when working below the water table. There are few details given but that such techniques are described at all seems amazing, considering the work environment on sites at the time. The book was both a text for the young engineer and a source of ideas for the civil engineer when in employment. From what dates are known about Mainwaring, this particular copy could have served him in both capacities during his career.

This brings us to ask, who were the contractors for the bridge construction, or was the bridge constructed by the Railways Department that Higginson had shortly before arrived in NZ to take charge of ? Some of these questions may have known answers, but they are not known to the writer. Answers to even a few of these questions would add considerably to our knowledge of how these pioneer engineers achieved what they did. This is presumably one of the motivations for collecting archive: to assist in reconstructing segments of past activity. Higginson remained in NZ. He went on to a number of other construction projects. His final post was with Wellington Gas Co.: he retired in 1898. He is one of many engineers, his contemporaries especially, some of whom are included in Furkert's ENZE, whose skills and achievements we still continue to benefit from, but about whose careers we have only limited knowledge. The Gorge bridge is a sufficiently novel and interesting structure of the period to warrant more detailed study.

Earlier we noted that the architect but not the engineer is identified on the official plaque on the Auckland War Memorial Museum. Many other similar examples of the engineer not being identified on foundation stones and commemorative plaques can be found. A useful task would be to compile a list of such omissions and then consider approaching owners of relevant infrastructure to suggest the engineer's name be added at the site. This sort of data gathering, being locally based, has the advantage of spreading the involvement around the membership and might unearth some unexpected facets of the particular works.

8. PRIORITIES FOR THE PROFESSION - 2.

Most of the discussion thus far deals with assembling and conserving various forms of physical archives and related materials. Here we consider a quite different aspect of our engineering heritage. What is discussed in the earlier parts of the paper relates primarily to the past. Here we consider the future: in particular the educational environment for the engineers of the future. We seek to outline the case for the young engineers, and other professionals with whom they are likely to work alongside in their careers, to be encouraged to study aspects of their respective professional heritages while still studying in the formal learning environment.

Courses in the history of engineering and, less commonly, of technology more generally, have been offered for many years as electives in the engineering schools in Canterbury and Auckland. The respective course structures have meant that for many of the years that these courses have been taught only students in Civil-based departments have been able to enrol. The same may or may not be true of other engineering schools. Staffing changes at Auckland and Canterbury recently could mean that these courses will no longer be offered. Adding courses to an already crowded degree structure is difficult: offering such courses as Electives may be the only avenue available. This would be a satisfactory outcome, so long as the degree regulations allow students in all specialities to participate. If such courses are successful then there would be scope to build on these beginnings and enable the subject to develop and evolve.

In many universities world–wide, and in relatively recent times, flourishing History of Science departments have developed. To be more specific, these are usually departments of 'The History *and Philosophy* of Science'. If we are serious about the subject of engineering heritage, then there is a strong case that we should be promoting serious studies in '*The History and Philosophy of Engineering, (or of Technology)'.* Particularly in the present global environment, the need for, and scope to assemble, a very worthwhile course for such study has never been greater. Study at an appropriate level within a faculty, with the possibility of separate departmental status sometime in the future, presents exciting prospects. At least one such study centre nationally would be a sound investment for the future.

Without a doubt there is ample scope to evolve courses that can both inform and intellectually challenge the best of the students in the future. If this outcome can be achieved then there is an enhanced prospect that there will be better dialogue and debate in the community, and between the professions, when national priorities with heritage implications are being set. The result should be greater scope for current and future community expectations to be met. The present economic crisis, and the political responses this is producing, is only likely to bring about improved outcomes if a 'long view' can be developed rather than continuing the short term thinking and decision taking that has dominated recent decades. This is another way of saying that we need to be better informed about the past, and in a more systematic manner, than we have been for decades. Engineering is mostly seen as a means to an end. The suggestion is that the engineering profession itself needs to be better informed and have a more rounded view of the engineer's role as to how the past contributes to the future. This is where the '*philosophy*' should be coupled to the '*history*', to produce an augmented study for future engineering heritage issues, and an interface with related disciplines.

Another aspect of 'heritage' issues in a general sense being legitimate course content for study in an otherwise vocational degree course such as engineering is that such 'history and philosophy' courses have the scope to perform a unifying role in what is currently a fragmented intellectual environment of autonomous and separate courses of study. Related to this circumstance is the possibility of dialogue, and hopefully fruitful collaboration, both for teaching and research, with Departments in the Arts and/or Science faculties. In some respects the advances in understanding engineering heritage, in the sense of academic study, has already been annexed by some 'History and Philosophy of Science' Departments around the world. An example is the recent extensive wealth of research that now surrounds figures such as Thomson, Maxwell and Rankine, the nineteenth century 'Natural Philosophers' and early engineering academic whom we have encountered in earlier sections of this paper and whose legacy, with others, provides the foundations on which much of our modern day engineering technology is based, [**12**].

There is much of value and interest in the achievements of the profession as a whole, over centuries. Mainstream history teaching and writing often refers to the products of engineering but often the professionals responsible for the creation of the works are not identified. The politicians *are* likely to be identified and discussed, but the professionals such as engineers are much less likely to feature! Some appreciation of heritage issues can be studied in the educational and vocational training phase, as well as during the working lives of the membership. The IPENZ Foundation - a recent initiative by IPENZ to widen the scope of outreach to the community at large has some stated aims that are close to some of the initiatives briefly described here. Recently received correspondence from the Foundation notes ' ..you are probably concerned about the low profile engineering still has in our society.'. This is a point discussed earlier here. But there is no single clear path to follow to overcome what many perceive as an ongoing concern for the profession. After adequate discussion, if a consensus can be reached, the sort of academic developments described in this section have the potential to provide a new initiative for the cultural underpinnings of the profession to be strengthened. There will be costs to be considered if a proposal to add courses for degree study is to be implemented. A suitable case must be made, with inputs from the profession, to the relevant academic agencies. But before any progress can be made the profession itself must consider all the relevant proposals and be convinced of the merits for the educational process as well as the medium and long-term benefits for society generally, the individual professional, the profession and engineering heritage studies in the widest sense.

9. A NATIONAL TECHNICAL LIBRARY!

This topic has been touched on earlier and has been left till last to discuss, since it is the least likely to be implemented any time soon. Suggestions for a big budget item such as a National Engineering and Technical Library, one of whose major functions would have to be archive collecting, have been made at various times in the past [**9,10**]. The original suggestion for such a national collection was probably that made by Evan Parry, an electrical engineer, on the eve of his departure from New Zealand in 1919,[**13**]. Parry had taken a leading part in introducing electrical power in New Zealand and was held in high regard. In the ninety years since, his original suggestion has hardly been discussed or taken any further. It could be argued that some of the spirit of what he was proposing was built-up in-house in the Public Works Department and Ministry of Works during their respective periods of dominance on the national scene and in the quasi public domain. With those collections now dispersed or alienated, in a sense the case for a National Technical Library goes back on the agenda.

Modern society, in the Western sense at least, depends vitally on employing technical services throughout the community. It is surprising then that there are not more robust library facilities specializing in the whole range of technologies spread throughout the nation. Teaching and research institutions would make the greatest calls on a facility such as a national technological library. As at present structured, the libraries at the engineering schools for example, cater for their students and staff as best they can. Archive functions do not feature highly among these services. Judging by some other National library structures, one feature that should be better represented in NZ than at present is archive collections relating to engineering and technologies generally. Enhancement of archive collecting in the technologies would put unexpected pressure on the capacity to house newly acquired materials as well as on requirements for specialist staff. Realistically the need

would be a separate library and possibly sited away from Wellington, for safety and user reasons. Potential sites have been suggested [**9**].

It would be in keeping with some overseas practice if a National Technical Library was also a Deposit Library for relevant materials covered by the local Copyright Act. How effective such a facility might be depends critically on the provisions of that Act. As at present structured the NZ Act would be of little benefit to a National Technical Library via deposit requirements, because of the narrow definition used for the meaning of 'published'. In the modern state 'published' should be synonymous with 'distributed', as is already the case with many of the older and more powerful nations. The present economic climate is a further reason why establishing a National Technical Library seems unlikely. But this is not to say that potential interested parties should not think through the priorities and benefits of such a facility. Nor should in-house collection development of archive materials be put on hold or not considered important. A prelude to future success in achieving a national collection with a primary focus on technology, including engineering, will in all probability only be after there has been greater participation in heritage conferences and the like into the future. Opportunities to acquire private collections and to benefit from bequests will be restricted until the whole concept has been fully debated, prioritised by the membership and the results communicated to potential donors and other sources of materials.

10. CONCLUSIONS.

Several public domain libraries in both NZ and Australia do have active policies to accumulate relevant engineering archive. But it needs to be acknowledged that the status quo is not attracting an adequate proportion of the potential archive of value into these collections. Our professional bodies need to revisit their policies on collection of such material and then discuss with other associated professions, libraries and museums whether there are further collective strategies that could assist with the gathering and making their collections available.

Proposing that the profession invest more resources and effort in seeking archive materials in a more active fashion may not meet with the support of a majority of colleagues, especially in these uncertain times. Fortunately there is much that the individual can achieve, even if collective or Institutional support and encouragement might be lacking. The hardware that professional engineering produces to enable a modern society to function is there for all to view and evaluate. These facilities have owners whose interests include the maintenance and continued functioning of this hardware. What is often poorly documented at the time such hardware was created is the personal details of the engineers and other professionals whose expertise gave rise to the creation of the hardware. If not well documented at the start the task of reconstruction later becomes difficult or may be even impossible. The contributions of several individual engineers are raised in the above paragraphs. Serious and worthwhile progress towards accumulating biographical data in particular is improving but much more could usefully be done. Collective effort will speed the process but individual effort will always have an appeal and adherents [**11**]. One measure of the effect of the 1980's upheavals relating to many records and archive materials of the Ministry of Works would be to know the present whereabouts of the sources used by the author,[**14**], when she was researching the history of the Ministry of Works a decade earlier.

The internet has an important role to play and will provide useful facilities for us all. The question of reliability and accuracy of Internet material will remain. However, this is not a competitive environment in the sense of winners and losers. Rather, the growth of the internet will add value to the original source materials themselves, from which the internet draws its copy and content, rather than in any sense make these source materials redundant. Hence there will be no reason to cease seeking to identify and ensure the preservation of original materials.

The time has probably come to review whether in Engineering Schools there should be content available in the B.E. Degree, and in the post graduate programmes, to study the '*History and Philosophy of Technology*'. This could be a sensitive issue with History and Philosophy in the Arts Faculty. There will be costs to be met. The benefits may take time to be felt. In the future this field of related study to mainstream engineering has the potential to reposition professional engineering in the social fabric, and in a beneficial manner for all parties. How these prospects can be assessed is not easy. The way forward is probably to move in this general direction as and when personnel and resources can be identified as being available.

A recent book, [**15**], though not dealing with engineering heritage, is an example illustrating what a benefaction can achieve for future generations in the field of cultural heritage. Engineering heritage collections could possibly benefit the community in the future if long term interest in the merits of heritage conservation can be seen to include technical as well as literary and other general cultural aspects.

This paper is dedicated to the memory of colleague and friend, Dr. Bruce Gamble (1942-2004). He, and his co-author Ian Stewart, [**16**], contributed an important paper to the second conference in this series. Both devoted much time to MOTAT, the transport and technology museum in Auckland. Several of the points made by them in 2000 are earlier expressions of points discussed again in the present paper. Their paper was awarded the inaugural Pollard Prize for the best paper at the Engineering Heritage 2000 conference. John Pollard (1923-1999) was intimately associated with the first conference in the present series, held in Christchurch in 1994. He was one of the founding fathers of engineering heritage studies in New Zealand.

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APPENDIX 1.
THE PAST INTO THE FUTURE.

One theme in this paper has been the alienation and/or loss of important engineering archives during the process of changing from government to private ownership of the Ministry of Works and other former government agencies. Only some of the losses have been identified. The core archive of major infrastructure completed during previous eras, such as as-built drawings and all the associated materials, has in many cases passed out of public ownership and an unknown portion of it has been destroyed. The same is true of Lands and Survey, the Railways and Electricity infrastructure. Looking back at the last twenty five years there has been a huge diminution of public domain engineering archive. Future generations will have to wrestle with the consequences.

Public pride and interest in these key infrastructure projects has been harmed in the process. There is ample evidence to show us that NZ Railways has a proud history. For example this arm of government of the day pioneered the design and deployment of the 4-6-2, Pacific Class, of steam locomotives in c.1901. The Pacific Class went on to become **the** most popular class of steam locomotive of all time. The passenger rail network in NZ was a key piece of nation building infrastructure. Today only a remnant of this service survives. With the recent re-purchase by the State of the rail network, and the scope that rail presents as the one transport mode able to meet the most stringent global warming targets, let us plan for a future where rail re-emerges as a preferred, efficient and environmentally sustainable means of both commuter and long haul passenger as well as freight transport. It seems to this writer that such a resolve is a natural outcome of the study of our Engineering Heritage. Studying the past to help us make wise decisions in the future is a core reason for such gatherings as the one we are attending. The present global financial instability is in these terms a wake-up call, to smaller nations especially, to examine the past carefully and to map out a more stable future, where local ideas and expertise are given a better chance to provide for future national needs. Rail in NZ has had an exciting and illustrious past. Current conditions present the mix of novel circumstances that could enable a revival of this earlier success.

Ref [**16**] details the considerable effort applied, as well as the difficulties experienced, in building the tramway system in Auckland, now over a hundred years ago. The trams served the then 'pioneer' and rapidly growing city of Auckland very well for fifty years. Then, quite quickly, about fifty years ago, and without much discussion or analysis of the consequences, all of this infrastructure was swept away. The uncomfortable feeling is that for the past several decades our cities have been deprived of the planning foresight shown by our grandparents' generation. Let us hope that this situation can be retrieved! Provision of a comprehensive generic urban public transport system, capable of providing a service superior to the private motorcar, is one of the unsolved civic problems in our cities and communities. Engineers have much to contribute to the discussion and decision taking. All the options need careful study. Most particularly, sub-surface rail should be in the mix. Several such systems in other cities around the world have celebrated their centennials. These systems have not been scrapped. Rather they have been added to. Appropriate heritage studies could serve to better inform the public, and arouse their interest, as an alternative to the political spin and lack of coherent planning that our communities often currently experience.

We are fortunate that there are several excellent books about NZ Railway's era of importance. The 2007 published '*Trainland - how railways made NZ' by Neill Atkinson* is a valuable recent survey. The reference section is especially useful for the non-specialist reader. David Leitch's 1972 '*Railways of New Zealand'* retains a special place in the literature, as does R.S. Fletcher's '*Single Track'* of 1978. Let us hope, and study the prospects, for a revival of the

urban rail systems, more especially for a modern Underground(U/G), especially in Auckland. Making such an ambitious statement may harm personal credibility but we should have absorbed from the study of the past that ambitious, but well thought through, schemes is what is currently needed, given the timidity of much of the decision taking for public domain projects in the recent past. A brief but worthwhile glimpse of the contribution made by one individual in the railways scene in NZ is the essay in DNZB5 by the late Nigel Stace where he writes about P.R. Angus's contributions to locomotive design: the K and J loco era! Fifty years on from now it would be fitting if similar essays could be written about local engineers having designed and built the underground track, passenger access and the rolling stock for a successful underground urban rail system in Auckland, for example.

The decisions facing our communities today relating to all aspects of global warming are important and not easily dealt with. Transport issues are a major component in the total picture. Judged by the content of the current public domain discussion, railways in both New Zealand and Australia are being more talked about and hopefully there is planning being undertaken by various agencies to rebalance the rail/road divide for passenger/freight transport nationally. But the conclusion thus far seems to be that the road vehicle lobby has by far the more active presence in the corridors of power. For example, discussion is well advanced in New Zealand to allow a substantial increase in road freight loads. The present 44 tonnes limit per unit of road haulage is being talked up to 53 tonnes. If such an increase passes into law the road haulage industry will be the beneficiary. This will be another victory for a sectional interest. The downstream costs through damage to roading infrastructure will be substantial and difficult to quantify in advance. If the limit is raised, as a co-lateral adjustment, the road user charges should at least be subjected to the same fourth power law as is expected to apply to the damage caused on the roads by the increased weight. No doubt there would be stiff opposition from the road hauliers to such a proposal. Any such sector benefits should be coupled from the outset with the charges the sector must expect to pay.

Enhancement of rail freight services, both in the public and private sector, needs to be seriously considered as a means to better balance the resources between rail and road. There are many insights to be had from a study of the evolution of rail and road developments over the past one hundred and fifty years. Also this is one activity that can be mounted with a relatively modest budget and can involve the whole community, from the young through to the old. The young could best be thought of as students working on a variety of related projects in their degree studies. Part of the studies should delve into passenger rail traffic, both urban and long distance, and to propose means that would need to be met to rebuild the usage back to what it was in the 'prosperous' period of the earlier history of rail travel.

In principle a railway system could be developed to use a wholly sustainable energy supply. Neither road vehicles nor aircraft can achieve this independence from sustainable (fuel)energy. Track-side banks of photo-voltaic panels coupled to distributed storage of energy in mini pump storage installations to utilize excess daytime power generation could be one scenario. There are many others. The incentive to consider novel methods is greater today than for decades. The opportunity should not be lost. The young professionals are the agency for such activity to thrive. There have been few positives emerging from the 2008 global financial crisis. Hopefully a shift to consider novel approaches in all manner of activities is one of the few benefits that might arise from the wreckage strewn aftermath of the global financial melt-down. This also fits well with the need for society to offer fresh incentives to the young in our communities to make constructive and potentially important contributions to the general good. 'History' and 'philosophy' have a role for the profession to consider in such times.

Auckland and Sydney, both key cities, are deep into dependence on the motor vehicle. Underground passenger rail systems are being constructed in many countries, in both the developed and especially the developing world. But none more so than in China. The Chinese are building new U/G track at such a rate that in a typical year, a similar length of track would provide Sydney with a new, fully comprehensive, region wide, urban public passenger transport system to satisfy all current and medium to long term future needs. Small nations are no doubt less capable of equipping their cities with such vital infrastructure! At least this is the response most often met with. As engineers we should be seeking the means to achieve such goals without generating a massive public debt burden. History shows us that analogous schemes were achieved in the first period of the railway era, and in cities far smaller than a present day Auckland or Sydney. Glasgow for example, [**17**], built an inner city U/G which has celebrated it's first hundred years. Parts of the London U/G are even older. Sydney has had it's 'Bradfield' era but even he had to wait a decade and a half before the main features of his proposals were implemented. What would he be thinking, planning and doing were he in his prime today?

Above all, we need the commitment from all, the public, the professionals and the politicians, to act on a twenty year time scale of infrastructure spend,[**18**]. Hopefully the financial excesses, risk taking at no personal cost to the takers and encouragement to personal greed, ushered in by the de-regulation era in the late 70's, have come to an end. Then long term good for the whole community, especially in transport terms, consistent with the achieving of global warming goals, could be upon us. Engineers we know have much to offer in such an environment.

APPENDIX 2.
PERSONAL ARCHIVE.

A worthwhile category of archive materials that could be selectively sought is personal correspondence and other 'association' materials. This is also one of the most vulnerable of categories of archive. Generally it is relatively undemanding of storage space. As an example, one small, known collection contains 'correspondence' received from the following on technical related subjects: E.(Eric) Ashby, A. G. Bagnall, J.F. Baker, J. C. Beaglehole, G. S. Beca, A. G.(Gordon). Bogle, K.N.E.(Bill)] Bradfield, family of Arnold Downer, C.W.(Cyril) Firth, E.(Eustace) N. Fox, C. (Charles) A. Fleming, R. J. P. (Pat) Garden, C.E. Inglis, N. (Neil) A. Mowbray, family of W. L. Newnham, Osborne Reynolds, I.(Ian) B.Reynolds, J.W. Roderick, family of F. S.(Stan) Shaw, L.(Len) Southward, R.V. Southwell, A. (Alan) L. Titchener, L.(Larry) B. Watts, H.A. Webb, L.(Les) C. Woods and others.