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THE MISSING DECIMAL POINT – A CONSTRUCTION MYSTERY

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The role of the construction historian may be likened to that of a detective. Working through the clues, both on paper or in the physical world, their analysis and careful research must be supported by even more careful logic and deduction. In this case the trail started in New Zealand, but quickly moved to the United States – and like all good detective stories has a satisfactory ending..

The year 2014, the month was January. It began with an unexpected discover of 3 sentences referring to a 1924 New Zealand conference:

> "In 1924, a conference of representatives of local bodies, architects, engineers, builders, timber merchants and saw millers produced recommendations entitled 'Recommended Minimum Requirements for Safe and Economical Construction of Small Wooden Frame Buildings'. These were designed to apply to shops, offices and houses of up to 3 storeys in height. These recommendations were published and were generally adopted since they represented what was considered to be good construction practice."(Cooney, 1979, p. 224)

Having spent a good number of years exploring the history of building technology in New Zealand, this was a new mystery – a conference few knew existed. Stopping only for three months, a visit was made to Archives New Zealand. Fortunately, the conference was well documented, from its planning in 1923 through to the final publication in 1924. The chief suspect was Alexander R. Entrican, who in 1921 at the age 23 had been appointed the first 'Engineer of Forest Products' in the New Zealand State Forest Service. The Service had been set up in 1919, with its first director L.M. Ellis starting work in 1920.

A preliminary study, presumably undertaken by Entrican, and completed in 1922 had found that:

> "building and constructional industries, consuming, as they do, more than half the timber used in the country, were shown to present many opportunities for the more economical employment of timber." (New Zealand State Forest Service, 1924b, p. 3).

This led to a plan to improve the efficiency of the use of timber in building which would increase the life and value of New Zealand's dwindling resource of native timber.

Links to the USA Building Codes Committee

Entrican had been active in collecting information on how other countries had improved the productivity of their timber construction. On 10 April 1923 asked the USA Building Code Committee (BCC) (New Zealand State Forest Service, 1924a, pt. 1) for a copy of their recent report "Recommended Minimum Requirements for Small Dwelling Construction: Report of Building Code Committee July 20, 1922" (Woolson et al., 1923a).

The Archives New Zealand files hold the prompt response of Frank Cartwright, BCC Secretary which: provided a copy of the report; set up a link with BCC member J.H. Newlin of the US Forest Products Laboratory; reported that there was a movement to standardise building codes in England; and reported on the success of the range of BCC publications (Cartwright, 1923). Each of these items had a long-term impact on the development of building controls or forestry in New Zealand. The BCC's role will be discussed later, but Newlin and Entrican established a strong professional relationship which led to considerable interchange of ideas and people between New Zealand the US Forest Products Laboratory. The New Zealand to England links were already strong, and in the years ahead led to the establishment of NZ Standards (Galbraith, 1939, p. 1) and building research organisations (Stradling, 1948).

In response to further brief correspondence from Entrican, Ira H. Woolson, BCC Chair, set out his philosophy for the development of a national building code, that it:

> "is impractical, especially in a country as large as ours with such diversified climate, materials, and methods of building", … but that … "state building ordinances … drafted with due regard to the rights and privileges of all citizens … to establish minimum requirements for the various forms of construction such as could be applied to buildings in a city of any size without undue hardship" (Woolson, 1924)

Entrican's reply was clear as to his view of the BCC's work,

Nigel Isaacs has made a collection of photographs showing the range of under-floor ventilation measures used in New Zealand from simple drilled holes to manufactured grilles. This is a small sample of his collection.

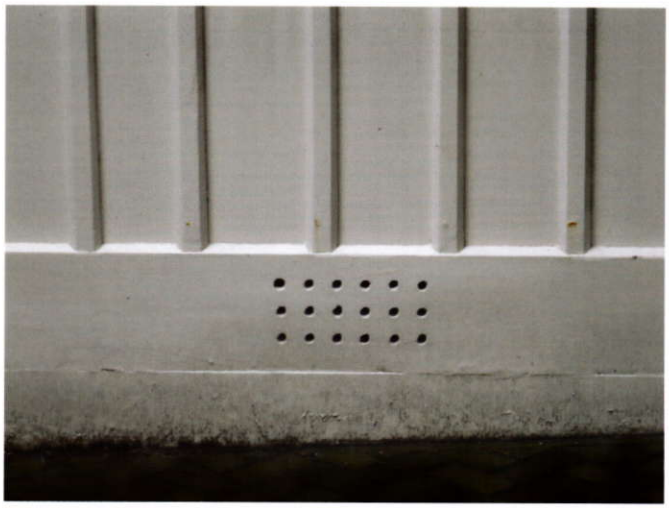

Fig 1. 1860s ventilation

Fig 2. Subfloor ventilation grille – 1860s

Fig 3. 1888 grille with architect's name. Timaru Royal Arcade

Fig 4. 1908 Ventilation grille.

Fig 5. 1910 ventilation – Government House, Wellington.

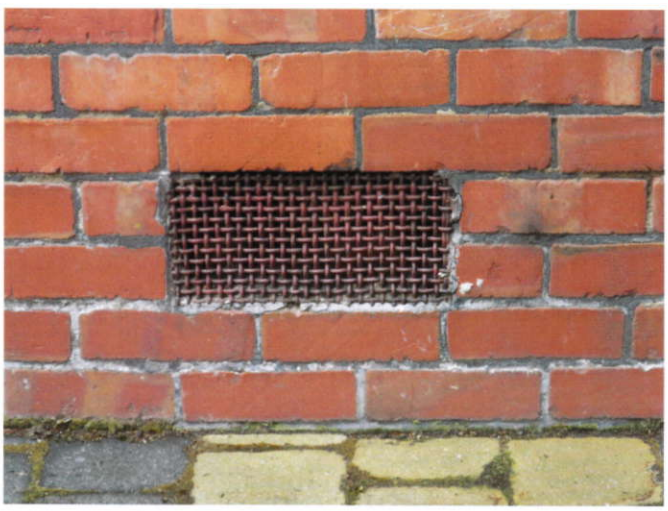

Fig 6. Airbrick in Dunedin

referring to the Forest Service's recommendations prepared for the 1924 conference regarding the use of timber in construction:

> "You will see that these have been based upon your Building Code Committee's first report which must prove an inspiration to all concerned with the Building Code problem. Many of your recommendations have been adopted in toto as it was felt impossible to improve upon them." (Entrican, 1924)

But we move ahead a little too quickly, as firstly the NZ conference had to be held.

1924 NZ Conference

The "Building Conference Relating to the Use of Timber in Building-Construction" opened on Wednesday the 18th June 1924 at 10:30 am in the Gothic-Revival style, Dominion Farmers Institute Building (completed 1920) in central Wellington. Chaired by the then President of the NZ Institute of Architects, William Page, the 42 attendees included 5 from central government, 13 from local government, 7 architects or engineers, 6 builders, 10 sawmillers and 1 fire underwriter. The afternoon session then started at 2 pm, with both morning (9.30 am start) and afternoon sessions on Thursday and Friday.

The Conference was divided into three technical committees:

> Committee A—To deal with the use of species and grades in buildings ;
>
> Committee B—To deal with the seasoning and preservative treatment of timber ;
>
> Committee C—To deal with constructional details of buildings

The technical committees reported back to the Conference in General Committee, where each recommendation was discussed, modified if required, and then recorded. An additional special committee was established to report on a number of fire-prevention issues, and a selection of questions were sent to the Government for response. The results were all reported, along with a proposed by-law "Minimum Requirements for Small Wooden-framed Building" (New Zealand State Forest Service, 1924b, pp. 5–6)

Before the conference Entrican had prepared a draft by-law for discussion. It was based in form on the BCC Small Building Code, but many of the details came from analysis of 37 New Zealand local government building by-laws. None of these dealt with sub-floor ventilation, which is required to ensure timber moisture can be kept below levels likely to lead to mould growth and decay. Although there had been various New Zealand requirements for raising suspended timber floors above the ground level for moisture management, until the 1924 conference no numerical value was provided for the ventilator area (Isaacs, 2019, pp. 376–377).

However, Section 14 of the pre-print paper provided to Committee C included:

> "All timber framing shall have a minimum clearance of 12 inches above finished grade level, and cross ventilation shall be provided for the space enclosed by foundation walls whether it be excavated or not. Such provision shall be at least 7 per cent of the area enclosed" (Entrican & Duncan, 1924, p. 18).

This recommendation had been reworded from the BCC small building code:

> "Where provision is not made for circulation of air within inclosed spaces next to the ground surface, dampness accumulates and timber decays rapidly. Openings for the admission of air help to prevent such decay and increase the life of the structure. The total area of such openings should be not less than 7 per cent of the ground area inclosed." (Woolson et al., 1923b, pp. 23, 71)

The conference attendees rejected 7% as excessive, noting that a 1,600ft² (149 m²) house would require 28ft² (2.6 m²) of ventilation on each 40ft (12.2m) side (Building Conference, 1924, pp. I4–I5). The conference finally recommended "*one square inch to one square foot of floor area*" (New Zealand State Forest Service, 1924b, p. 16) (1 to 144 or 0.7% of the floor area). The conference transcript covers only the plenary sessions, and not the Committee where the detailed debate was held. The original source of the shift to 0.7% has not been found, but the two speakers in favour represented architects (Mr F.E. Greenish, Wellington) and engineers (Mr J. Maxwell, Auckland City Council) (Building Conference, 1924, pp. I4–I5).

Even so, it would appear this recommendation was not initially used. For example the City of Auckland City By-law Number 1, passed on 15 April 1925, required there to be 9 inches (23cm) clear between the ground and the underside of the joist, and this space be "*thoroughly ventilated by means of suitable and sufficient air-bricks, or some other effectual method*" (Auckland City, 1925, para. 146).

7% or 0.7%?

Why 7% - surely 0.7% would be more sensible? Would careful detective work resolve this issue? A Fulbright

Scholarship in 2016 supported visits to the different archives holding material relating to the BCC. Early one evening in the Minnesota Historical Society Library, St Paul a hand annotated copy of the final committee draft of the Small Dwelling Code was found in the records of Edwin Hacker Brown, BCC member and architect from Minneapolis. There in Hacker Brown's handwriting was an addition to the typescript:

> "The total area of such openings should be not less than .7 percent of the ground area included" (Brown, 1922, p. 98, typescript)

The decimal point had indeed been present, but not been included in the typeset final version – some 13,000 km from Wellington the solution was revealed.

Interestingly, the error still appears in the 2nd edition of the Small Dwelling Code (Hatt et al., 1932, p. 32), but as Brown died in 1930 and apparently did not participate in the revision, and the other committee members had limited (if any) experience in basement-less houses, the committee may just have lacked the necessary knowledge to implement a correction.

The case was solved!

No science-based justification for either the 7% or the 0.7% ventilation-area to floor-area has yet been found. It would appear that the "1 inch per square foot" (1/144 = 0.7%) created in the days of imperial measurements was a simple "rule-of-thumb" to be followed by craftsmen working on site, and as it seemed to work there was no reason to change it.

By the 1940s the value was found to be more than adequate and was halved to ½ inch per square foot or 0.35%, a value that carries on in modern codes such as the performance based New Zealand Building Code Clause E2 "External Moisture".

Thoughts for the future – keeping hold of the past

There are many other tales of misplaced decimal points- the surprised shopper's purchase of 1.018 kg of pumpkin being charged as 1018 kg[1] is at the amazing end of the scale, while sadly the patient who died after being given 10 times the correct dosage of medication[2] is at the tragic end. Primo Levi gives an example of another transcription error from his work as an industrial chemist when using a typewritten version of a test formula for evaluating a pigment which had never (and could not ever) work. He searched for the previous obsolete version:

> "In a dusty archive I found the CS (Checking Specification) collection no longer in use, and there, lo and behold, the preceding edition of the chromate card bore the direction to add "2 or 3" drops, not "23": the fundamental "or" was half erased and in the next transcription had gotten lost."(Levi, 1986, p. 157).

What lessons can be learnt from this 3-year project to discover a missing decimal point?

Perhaps the most critical message to the researcher is the need to always go back to original sources – no matter how hard this might be. A key corollary is that it is important to ensure the original sources are not thrown away once the project has been completed. The background material may be hiding a key fact (or mistake) that has been overlooked or ignored in the reporting or final document. A future researcher with a different mindset might have a very different understanding of the issues, or even be able to use new analysis to create a new understanding of the old data.

The push for libraries, and to a lesser extent archives, to decimate their physical holdings in favour of electronic version may be a short-term money saving process, but in the long term it will be seen as short sighted. Even if every book in the world was available in digital form this would still be a problem. The digitisation must be 100% (not 99.9999%) perfect – a folded corner or difficult binding margin in the only digital version may make the book inaccessible or not useful for research. More likely is that small run publications or those from small countries are never even considered for digitisation but can be easily "downsized". Today's research libraries and archives are a treasure trove of material which hold unknown future opportunities.

Egyptian papyrus, just like the hand-amended notes from a 1922 committee meeting, are still readable today (although not always understandable!). The slow-motion crisis of the relentless change of technology will create new problems. For example, the 5 ¼ inch floppy disk is now almost impossible to read – is there any guarantee that data held in a USB memory stick will still be readable in 20 years, or that a particular file storage format will still be accessible?

While the life safety aspects of building codes continue to receive wide attention, many other code topics are also important. In this case, understanding the evolution of a comparatively minor building control, one which is not even required in locations which do not have suspended ground floors (in the USA termed "first floors"), revealed not only the long time required to create "deemed to satisfy" solutions but also the lack of research into many parts of the modern building code (Isaacs, 2019, p. 385).

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[1] https://www.stuff.co.nz/business/90448729/misplaced-decimal-point-creates-very-expensive-pumpkin

[2] http://www.stuff.co.nz/national/94830442/Nurse-gave-patient-10-times-the-correct-dosage-of-medication-on-day-he-died

References

Auckland City. *The Auckland City By-laws Nos. 1 & 2 1925.*, (1925).

Brown, E. H. (1922, July 20). *Final Report, Small House Construction, 1922*. Retrieved from Minnesota Historical Society Library. (P1456 Brown, Edwin H. Building Code Com. Papers)

Building Conference. (1924). *The Use of Timber in Building Construction—Conference Transcript*. Retrieved from Archives NZ Wellington. (ADSQ 17639 F1 W3129/368 SP 05.03)

Cartwright, F. P. (1923, May 21). *Building Codes. Letter to Chas. H Entrican, Engineer, for the Director. State Forest Service, Wellington, N.Z.* Retrieved from Archives New Zealand, Wellington. (ADSQ 17639 F1 687 8.61 P12. Parts 1 & 2)

Cooney, R. C. (1979). The Structural Performance of Houses in Earthquakes. *Bulletin of The National Society for Earthquake Engineering, 12*(3), 223–237.

Entrican, A. R. (1924, July 9). *Letter to Ira H. Woolson, National Board of Fire Underwriters, 76 William St, New York.* Archives NZ Wellington (ADSQ 17639 F1 687 8.61 P12. Part 2).

Entrican, A. R., & Duncan, F. A. (1924). *The Use of Timber in Building Construction (preprint)*. Retrieved from Archives NZ Wellington. (ADSQ 17639 F1 W3129/368 SP 05.03)

Galbraith, A. R. (1939). *The New Zealand Standards Institute. Its Origin, Objects, and Organization Being a Report, Synopsis, and Technology*. Wellington N.Z.: Government Printer.

Hatt, W. K., Kahn, A., Payne, W. A., Miller, R. P., Whittlemore, H. L., Newlin, J. A., … Taylor, J. S. (1932). *Recommended Minimum Requirements for Small Dwelling Construction: Report of the Department of Commerce Building Code Committee*. Retrieved from http://archive.org/details/recommendedminim18hatt

Isaacs, N. P. (2019). Evolution of sub-floor moisture management requirements in UK, USA and New Zealand 1600s to 1969. *International Journal of Building Pathology and Adaptation, 37*(4), 366–394. https://doi.org/10.1108/IJBPA-06-2018-0052

Levi, P. (1986). *The Periodic Table*. London: Sphere Books Ltd.

New Zealand State Forest Service. (1924a). *Building Conference*. Retrieved from Archives New Zealand, Wellington. (ADSQ 17639 F1 687 8.61 P12. Parts 1 & 2)

New Zealand State Forest Service. (1924b). *Recommendations of Building Conference Relating to the Use of Timber in Building-Construction.* Wellington N.Z.: Government Printer. Archives NZ Wellington.

Stradling, R. E. (1948). *Report on Building and Civil Engineering Research in New Zealand*. Wellington, N.Z.: Geo. W. Slade Ltd.

Woolson, I. H. (1924, June 6). *Building. Letter to Alec R. Entrican, Secretary to Conference, Office of the Director. State Forest Service, Wellington, N.Z.* Archives New Zealand, Wellington (ADSQ 17639 F1 687 8.61 P12. Parts 1 & 2).

Woolson, I. H., Brown, E. H., Newlin, J. A., Hatt, W. K., Russell, E. J., Miller, R. P., … Cartwright, F. P. (1923a). *Recommended Minimum Requirements for Small Dwelling Construction: Report of Building Code Committee July 20, 1922*. Retrieved from http://archive.org/details/recommendedminim01wool

Woolson, I. H., Brown, E. H., Newlin, J. A., Hatt, W. K., Russell, E. J., Miller, R. P., … Cartwright, F. P. (1923b). *Recommended Minimum Requirements for Small Dwelling Construction: Report of Building Code Committee July 20, 1922*. Retrieved from http://archive.org/details/recommendedminim01wool

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