ADOPTION OF THE
3ft. 6ins. GAUGE
FOR
QUEENSLAND RAILWAYS


Presented to a Meeting of the Society
on 26 May, 1983.

The 3 feet 6 inches (1067mm) gauge for government railways in Queensland was recommended by the engineer Abraham Fitzgibbon. There was considerable uncertainty at the time about the technical soundness of the recommendation. It would seem the government’s inability to finance anything other than a cheap railway and Fitzgibbon’s persuasiveness swung the decision. The standard gauge as used in Europe, North America and New South Wales and from NSW into South Brisbane is 4ft. 8½ins. (1435mm). Broad gauges are 5ft. and above, medium between 3ft. and 4ft., and narrow of less than 3ft.

Abraham Coates Fitzgibbon was born in Ireland in 1823 and was trained in surveying, architecture and engineering. He was first assistant engineer, and then for five years agent and manager for a contractor building railways in Ireland (5ft. 3ins. gauge). In 1852 he was engaged by Fox Henderson and Company and other British capitalists to examine a railway route in the U.S.A. with a view to their tendering for its construction. He spent a further four years in the U.S.A. and Canada, becoming conversant with American engineering practice.

From 1857 he worked for two years surveying and constructing the 5ft. 6ins. gauge Ceylon Railway until the company failed. He represented the chief resident engineer, W.T. Doyne, until the latter’s arrival in Ceylon.

Mr. Knowles, who was born at Dalby (Q.), has had a long interest in Queensland’s railway history. He was Secretary (1957-60) and President (1962-68) of the Queensland Division of the Australian Railway Historical Society and is the author of several short books and articles on the subject.
In 1860, Fitzgibbon and Doyne were engaged to select a railway route from Nelson, New Zealand, to a copper mine. Fitzgibbon surveyed and built this Dun Mountain Railway and worked it for a year. It was of 3ft. gauge, 13.4 miles long, worked by gravity with the load, horses hauling up the empty wagons. The first railway in New Zealand, it climbed to 2800 feet altitude, with much 1 in 20 gradient, and was very sharply curved. Doyne left in 1863 to build a railway in Tasmania, and Fitzgibbon went to Sydney.

Before he left New Zealand, Fitzgibbon recommended the 3ft. 6ins. gauge to Wellington Province for a railway to the Wairarapa, and surveyed a 3ft. 6ins. gauge line in Nelson Province. These lines were not built.

In newly separated Queensland of the early 1860s, communications were very poor, and the Moreton Bay Tramway Company, formed to build a wooden rail, horse worked, standard gauge line from Ipswich, the head of navigation, to Toowoomba in return for grants of land, had failed. The government decided to build a railway itself with borrowed capital. While a Bill to allow this was under debate, Robert Tooth and Company of Sydney offered to build a light railway from Ipswich to Toowoomba, Dalby and Warwick in return for government land scrip and debentures. The government declined, preferring to enhance the value of the land by building its own line.

AN ELECTION ISSUE

The Railways Bill was passed only on the Speaker’s casting vote, and the government decided on a dissolution. At the ensuing election of June 1863, fought on the issue of government construction of a railway to the Darling Downs, the government increased its majority and reintroduced the Bill. The question of gauge had not yet arisen.

Tooth engaged Fitzgibbon and sent him to Queensland to look over the country for his proposal. When that lapsed, the government engaged Fitzgibbon to report on the proposed railway. By 9 July 1863, he had submitted his report on the line, and recommended it be built to a gauge of 3ft. 6ins.

Essentially, he proposed a light railway on which locomotives of 10-11 tons could haul 160 tons on the level at 15 to 20 mph, 65 tons on a gradient of 1 in 100 and 35 tons on 1 in 40. He claimed there was nothing novel about light railways or locomotives (he mentioned the weight of Stephenson’s “Rocket” as 9 tons, actually an overstatement). He stated that Sir Charles Fox and other eminent British engineers were strong advocates of the type of railway he proposed, and that they were having such lines constructed in India and upon the European continent, as feeders.
The government were pleased to have a relatively cheap railway recommended to them. The roads were shocking, the Colony had a tiny population and could not afford heavy expenditure on railways. They took up the recommendation. Fitzgibbon’s report was laid on the table of the Legislative Assembly on 30 July 1863, and debate on the Railways Bill commenced on 4 August. The Bill was for an Act to make Provision for Construction by the Government of Railways and for the Regulation of the Same. Clause 1 provided that the Governor in Council could cause to be made a line of railway from Ipswich to Toowoomba and such other lines as may thereafter have been

Abraham Fitzgibbon, on whose recommendation the 3ft 6ins gauge was chosen for railways in Queensland.
Clause 9 provided that the plans and book of reference of every railway be laid before Parliament; when approved by resolution of both Houses, it would be lawful for the Governor in Council to cause such railways to be made. But Clause 10, as proposed and passed, provided that no such resolution was required for the section from Ipswich to the Little Liverpool Range, the first part of the line to the Downs (i.e. the government could build this section on the authority of the Act itself). The Act did not mention gauge. Hence the first section could be built to a gauge determined by the government, and would then set the gauge for later railways of which Parliament did have to approve.

**NARROW GAUGE OPPOSED**

The (Moreton Bay) *Courier* was very critical of Fitzgibbon's proposals, wanting to know whether a trunk line had ever been built to a gauge of 3ft. 6ins., and more details of the examples he quoted. It claimed light locomotives had not been built to work on gradients of 1 in 40. It also criticised his traffic forecasts, and the way construction costs had been estimated. Fitzgibbon had travelled quickly over the country, and used the Tramway Company plans (which had been purchased by the government) as a basis. He relied on his experience (not inconsiderable where mountain railways were concerned) to form an estimate; he had not been asked to make a detailed survey. The question of estimates generated considerable heat, but will not be considered further here.

Both government and opposition were agreed on the need for railways. The opposition wanted parliamentary control of the first section, and was concerned about adopting what it saw as untried technology on the advice of one man. It also wanted to give the Act application throughout the Colony, so that a railway could be built from Rockhampton, and in this it was successful. The Secretary for Lands and Works, Macalister, was firm that it was only on the basis of the 3ft. 6ins. gauge that the Bill was brought forward, and that the government would "probably" (the word is used in the *Courier* of 14 August 1863) take the advice of some other engineer on the practicality of that gauge. The power taken in Clause 10 was, he said, to allow progress to be made during the parliamentary recess. On 18 August the Bill received a third reading in the Assembly and passed to the Legislative council.

The Council decided to examine all knowledgeable persons at its bar before reaching a decision. Fitzgibbon explained that he started with the need for trains of 160 tons on the level at 20 mph and 35 tons on the range at 10 mph. This led to a requirement for a certain size of locomotive, and in turn for a certain standard of permanent way. He claimed to have the authority of William Bridges Adams (an inventive
British engineer), Sir Charles Fox (an engineering consultant) and two British locomotive builders that a 12 tons locomotive would perform that task, and that a 3ft. or 3ft 6ins. gauge line would carry it at 20 mph. He handed in a plan of a locomotive proposed by Stephenson and Company for the 3ft. 6ins. gauge line he had suggested in New Zealand and sent to him there by Sir Charles Fox. He claimed that 3ft. 6ins. gauge lines were then being built in India. Other parts of his evidence were concerned with speed, oscillation of locomotives, width and centre of gravity of carriages on the 3ft. 6ins. gauge, axle loads and the working of long railway inclines. He said the locomotives he proposed for Queensland would be similar to those working on the standard gauge in the U.K. in 1839-40. He admitted the 3ft. 6ins. lines in India were feeder lines to the broader gauge, whereas the Dalby line was a trunk line, but he was confident the 3ft. 6ins. gauge would answer all requirements for a hundred years. He said he estimated that standard gauge on the Ipswich to Toowoomba line would cost 41 per cent more. (This was based on the need for the wider gauge to have curves of 8 chains radius, compared with the 5 chains he used on the 3ft. 6ins., on both of which he claimed the resistance was the same.)

EXPERT VIEWS DIFFER

H.T. Plews, a roads engineer in the Colony, gave evidence. He had experience in railway construction in England, and had laid out lines there, in N.S.W. and New Caledonia. He had checked the plans of the Tramway Company before the government bought them. He thought standard gauge would be cheaper in the long run on account of traffic growth, but had seen locomotives on mineral lines of 3ft. 6ins. and 4ft. gauges, and knew of one of 18 inches gauge at a British workshops. He did not consider the 3ft. 6ins. gauge unsafe at the speeds proposed. William Coote, who had been engineer to (and a leading promoter of) the Tramway Company, had been superintendent of works on railway construction in England. He preferred standard gauge, but considered a locomotive could work on a gradient as steep as 1 in 25. A.C. Gregory, the Surveyor-General, thought 3ft. 6ins. less safe and conferring no economy compared with standard gauge.

No engineers from other Colonies were called. The Courier reported on 28 August, however, that South Australia had received evidence from eminent (but unnamed) authorities that the 3ft. 6ins. gauge would be suitable for cheap railways.

An amendment to insert a Clause specifying the gauge be 4ft. 8½ins. was lost, and on 3 September the Council returned the Bill to the Assembly without amendment. On 4th the Bill received Royal Assent, still with no mention of gauge. Presumably to ensure the government fulfilled its promise to investigate further, the Council
sent a message to the Assembly on 2nd stating that while it approved the intended spirit of economy, it urged the Assembly not to adopt the 3ft. 6ins. gauge without having further evidence of its safety and fitness, not only for the present, but future wants of the Colony.

On 8 September, Mackenzie, leader of the opposition to the proposals in the Assembly, moved that a committee consider the Council message. All the arguments were rehearsed again: 3ft. 6ins. gauge not used elsewhere for passengers; possible failure; small savings compared with standard gauge; the steep gradients needing powerful locomotives which could not run on the 3ft. 6ins. gauge; the government rushing 3ft. 6ins. on the public and the House; and so on. Again Macalister replied that there were considerable savings from the 3ft. 6ins. gauge, that it was safe to 25 mph (on which questions Plews agreed with Fitzgibbon), and that unless the government could build a railway economically it could not built one at all. He said (according to the Courier) the government would obtain views of eminent engineers in England about the gauge — Fitzgibbon’s report and application for such views had already been despatched, and an answer would be back before it was possible for the government to adopt any action respecting gauge. A motion on 11th that the Governor be asked to lay on the table such correspondence as may have been addressed to English or Colonial railways having reference to the adoption of the 3ft. 6ins. gauge, seems not to have been proceeded with in the light of this answer. The opposition walked out on two occasions, destroying the quorum. Eventually, on 11th, Herbert, the Colonial Secretary (Premier) moved the previous motion. This procedural device meant the executive took all responsibility. His motion was carried. The Courier reported next day that there was relief the question had been disposed of.

EQUIPMENT ORDERED

Even before Parliament rose on 22 September, however, and before any reports had been received from other engineers, orders were placed for equipment for the railway, to the gauge of 3ft. 6ins. The indent was sent from Brisbane by the Secretary for Lands and Works on 20 September. Two days before, Sir Charles Fox in London had been asked to be agent and consulting engineer, no doubt on Fitzgibbon’s recommendation — they had been associated since Fitzgibbon’s engagement in the U.S.A. in 1852. On 26 October 1863, Fox wrote to Fitzgibbon that Fitzgibbon’s judgement in recommending the 3ft. 6ins. gauge was sound. He, Fox, claimed to be then constructing a 3ft. 6ins. gauge line in India, and that a gentleman with whom he was well acquainted had successfully introduced a similar gauge into Norway and Sweden “...where the government had received it with much favour. The lines have been working
successfully for some time and are about to be largely extended.” A
month later Fox wrote to Macalister with his favourable opinion on on
Fitzgibbon’s report, saying “3ft. 6ins. will be amply sufficient”, and
accepting the position as agent. Also enclosed was a letter from G.
Berkley, M.I.C.E. to Fox, agreeing with Fox’s opinion (ref 5). These
letters would have been received in Queensland late in January 1864,
over four months after the order for 3ft. 6ins. gauge equipment had
been sent.

When Parliament resumed in April 1864, the plans and sections of
Section One, Ipswich to the Little Liverpool Range, were laid on the
table on 28th. These did not require parliamentary approval, on
account of the aforementioned provision of the Act. They were of
course to the 3ft. 6ins. gauge. On 10 May, when the plans for the
sections from the Little Liverpool Range to Dalby were laid on the
table, several questions were asked. The third, about locomotives,
brought the reply that a drawing of a 3ft. 6ins. gauge bogie engine, by
Manning Wardle, had been laid on the table during the previous
session to contradict the assertion that no engine on such a gauge had
ever been made, and that the locomotives ordered for Queensland
were not bogie engines, but much more powerful. 2

On 13 May, the Opposition moved for the laying on the table of the
correspondence between the Secretary, Fox and other engineers with
opinions on the 3ft. 6ins. gauge, and about survey and construction of
the Southern and Western Railway. Mackenzie castigated the
government for going ahead before opinions had been obtained. The
only information available was that obtained by the *Queensland Times*
from Macalister with great difficulty. This motion was passed,
and the correspondence was tabled and printed (ref 5). Included were
an account of the opening of a 4ft. gauge line in India in November
1863, a letter from the Engineer in Chief, Bombay not doubting the
efficiency of the 3ft. 6ins. or 4ft. gauges, and the correspondence from
Fox mentioned above.

On 17 May, Mr. Douglas moved for a return of gradients and
curves between Gatton and the summit of the Main Range. The plans
of this section were then on the table of the House, but could not, he
claimed, be readily understood. The government replied it had done
all the law required. The Opposition countered with the novelty of the
experiment, the government’s treatment of the Council suggestion of
caution, and its taking action during the recess before other views
were obtained. The only outside opinion on the gauge was that of Fox,
who was the government’s paid agent, and the correspondence laid
before the House consisted solely of replies (and then only extracts in
some cases). The government had broken promises, and much public
money could be lost. Once these points had been made, however, the
motion was withdrawn.
On the same day the Assembly debated its approval of the extensions beyond the first section. Macalister stated that the 3ft. 6ins. gauge permitted curves which saved a great deal of construction, quoted from the correspondence, and stated that Fitzgibbon’s surveys and engineering were cheaper per mile than such work in New South Wales and Victoria. The Opposition countered that the view of the Institution of Civil Engineers had not been obtained; advice had not been sought in New South Wales and Victoria; it seemed the cheaper was the railway the better; construction over the Blue Mountains in New South Wales had not shown standard gauge to be more expensive (Courier accounts of the debate do not give the basis of this claim); while Mr. Taylor referred to the intended line as a “mere toy railway”. Construction of the railway over the Blue Mountains had commenced only in 1863 and was not available as a model; nor was the line to the N.S.W. southern highlands yet open.

The government stated that at Fitzgibbon’s request, W. Doyne (Fitzgibbon’s former superior) had sent a Mr. Latouche to check Fitzgibbon’s survey, and that Latouche favoured the proposed railway; that Sweden and Norway had opened railways on the same principle; and that arrangements had been made to build similar railways in India. It was all largely beside the point: 3ft. 6ins. gauge equipment had already been ordered. The plans for the extensions were approved.

**FIRST SECTION OPENED**

The first 21 miles section, that authorised by the Railways Act itself, from Ipswich to Grandchester, was opened for traffic on 31 July 1865. At the opening ceremony Fitzgibbon is reported to have said that the 3ft. 6ins. gauge, together with the sharp curves and gradients introduced to keep the works at a minimum, reduced the line to a low power railway, of that there was no question. He is reported to have said there was no material economy, commensurate with the loss of power, from narrow gauge when flat curves were possible, but it was otherwise where there was broken ground. Had curves of eight chains radius been used on the Main Range, the cost in viaducts alone would have risen from £6000 to £35,000 per mile. He described it as a modest railway, but easily able to accommodate 800 tons of goods and 1600 passengers daily.

The extension to Toowoomba, incorporating the Main Range ascent which had influenced Fitzgibbon’s choice of the 3ft. 6ins. gauge, was opened on 1 May 1867.

There were problems — disputes between Fitzgibbon and the contractors, the contractors’ work, Fitzgibbon’s design of some features, the 1867 financial crisis, disputes between Fitzgibbon and the government, an unusual locomotive design proposed for economic
An early mixed passenger and goods train crossing the original road and rail bridge at Ipswich. This bridge was designed by Fitzgibbon, and both it and the train demonstrate the light railway principles he recommended. (Late S.W. Petford collection)

working of the Main Range, and Fox’s supervision of work in the U.K. But there is no evidence of gauge being the source of any problem. While the track, bridges and locomotives were light, the civil engineering was substantial, as the mountainous country demanded, and the route is still followed almost completely to this day. Opposition to Fitzgibbon on misguided grounds, and his disputes with the government, principally over relations with contractors, led to his contract as Engineer-in-Chief not being renewed. He left Queensland in mid-1867 and returned to England (via Canada where he advocated the 3ft. 6ins. gauge, again for lines with which Fox was associated) and retired.

Meanwhile a railway had been built from Rockhampton 30 miles to Westwood, to assuage northern interests for building the first railway in the south. It too was 3ft. 6ins. gauge, and Fox was again the agent, but its engineer was H.T. Plews.

With hindsight it is possible to say that Fitzgibbon and Fox presented inadequate evidence of medium gauge railways already operating, some with locomotives. The gauge was common in Britain in the pre-locomotive era of horse operated tramways. Lines of 3ft. 6ins. to 3ft. 9ins. gauge existed in Shropshire before 1605. By 1830, when the Liverpool and Manchester Railway, for which steam locomotives were adopted, was opened to the standard gauge, there
One of the first four locomotives on the Queensland Railways, 24 tons with tender in working order, designed to haul the light trains Fitzgibbon considered sufficient for the time.

(Queensland Railways)

were at least 70 medium gauge horse tramways aggregating at least 344 miles (although there was a greater mileage of such lines of gauges between four and five feet). They existed in Europe also, and one of 1106 mm (3ft. 7½ins.) gauge in Bohemia, 197 km long by 1836, was then the longest railed way anywhere. There were also horse lines of 3ft. 8½ins. gauge in N.S.W. and 3ft. 10ins. in Victoria when the Queensland gauge debate began.

Furthermore there were locomotives on the medium gauges very early, and their use was more widespread in 1863 than Fitzgibbon or Fox reported. They include the third locomotive ever (1808), four in Britain before the “Rocket” of 1829, and twelve by 1860. Four existed in Sweden by 1858, and several in Austria-Hungary and Belgium. The 1140 mm (3ft. 9ins.) gauge Antwerp to Ghent line of 50 km in Belgium, opened in 1844, was the first medium gauge locomotive worked main line.

It was in Norway that the medium (3ft. 6ins. English) gauge was first developed into the mature, systematically built light railway, although initially only for local lines. The first such line there opened in 1861. C.D. Fox, son of Sir Charles, knew of this line. As the Foxes did not mention any of the others, it would seem it was the limit of their experience with the medium gauge when they endorsed it for Queensland in 1863. They used Norwegian equipment as a model
when specifying the equipment for Queensland and for the 3ft. 6ins. line in India to which they were consultants.

The steam powered medium gauge railway was also adopted elsewhere contemporaneously with Fitzgibbon's recommendation for Queensland, in Algeria, France, Portugal, and across the Mt. Cenis pass in Italy. The large medium gauge networks — South Africa, Japan, Indonesia, New Zealand, India, Brazil and Argentina — were all started later than Queensland's, in the early 1870s. The 3ft. gauge lines in the U.S.A., metre (or near) gauge secondary lines in Europe, and 3ft. 6ins. in other Australian States all commenced in the 1870s.

OLDEST ON MEDIUM GAUGE

The Queensland Railways are now the oldest medium gauge network. The medium gauge lines which preceded it have been converted to wider gauges or closed. Queensland could be said to be the first place to choose the medium gauge for principal lines and for a long incline. (Fitzgibbon in his 1863 report says he chose 1 in 50 as the steepest gradient because the Toowoomba line would be the trunk to feeder lines to a vast interior). Even if "principal lines" means little when the expected traffic was so light, Queensland was the first place to choose the medium gauge for lines of any length.

Less than a decade after the opposition to the cheap system of railways proposed by Fitzgibbon, Queensland was itself investigating building even cheaper lines. A Royal Commission in 1872 examined engineers who recommended gauges down to 2ft. 6ins. and even lighter construction of 3ft. 6ins. gauge lines. The Commission recommended the conversion of the 31 miles between Rockhampton and Westwood to a gauge of 2ft. 9ins. for the cheaper extension inland to that gauge of what is now the Central Line. The recommendation was not acted on, and the gauge of the government system has remained 3ft. 6ins. In 1879 the Chief Engineer of the system reported to the Commissioner on ways of building railways more cheaply. The North Bundaberg to Mt. Perry and Maryborough to Gympie lines were then being built to lighter standards than previously used, standards which soon proved too light.

The saving in track and structures of a given strength from use of the medium gauge are not very great. Light construction (rail weight and ballast quantity) can be adopted on any gauge (e.g., considerable use of 40lbs. to the yard rails on the 5ft. 3ins. gauge in South Australia). Sharp curves confer a saving on earthworks and structures by enabling a line to round promontories and head ravines, as on the Queensland range lines. Again, sharp curves can be adopted on any gauge, but in practice, on a given radius curve, a longer rigid wheelbase can be used on medium compared with standard gauge, thus allowing larger locomotives in the days of steam.\(^3\) The resistance to motion caused by
curves, a question raised by Fitzgibbon to help justify 3ft. 6ins., is of less importance, as gradient so dominates it.

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Even if a wider gauge had been chosen for railways in Queensland, the limited ability of the Colony to finance them would have meant those railways would have been light, steep and sharply curved, with relatively light and slow trains and high operating costs. It was, I think, justifiable in the circumstances of 1863 to choose to build a light railway. With the knowledge of the time, and the advice available, that was probably a medium gauge railway. While the initial light railway has been successively strengthened as traffic developed, the cost of gauge conversion at any time has locked the system into its original gauge. Not that there has ever been any real reason to change the gauge as the system has always been largely self-contained, and it is doubtful if gauge per se has prevented the Queensland Railways from doing anything developmental, for the inevitable lightness of construction has been the major limitation on their performance. On the world stage, some of the heaviest trains run on the medium gauge. The 3ft. 6ins. gauge was not a bad choice for 1863.

FOOTNOTES

1. The communications were referred to in a question in the Assembly on 4 September, and were tabled and survive (although the drawings, previously tabled, have not). Parliamentary records.

2. Just what this locomotive was is not known. It cannot be traced from locomotives built by Manning Wardle up to 1863, and it was certainly not the fourteenth they built. An editorial in the Courier of 21 August 1863 mentions its being illustrated in a London magazine, as a contractors' locomotive available in any gauge from 3ft. upwards.

3. The longest rigid wheelbase allowed on the few New South Wales lines with 5 chains radius curves was 11ft. 3ins., whereas Queensland allowed 12ft. 6ins. on that radius, and even on 4 chains radius.
PRINCIPAL REFERENCES

1 Votes and Proceedings of the Legislative Assembly (V & P), Journals of the Legislative Council (JLC), and The (Moreton Bay) Courier, for debates.


3 Evidence taken at the Bar of the Council on the Debate upon the Railways Bill, JLC, 2nd session of 1863, paper 17.

4 Railways Act 1863 (27 Vic 8), Queensland Government Gazette, 1863, p 753.

5 Correspondence on Light Railways, V & P 1864, p 1149.

6 Minutes of the Proceedings of the Institution of Civil Engineers, London (MPICE):
   a Minutes of the Proceedings of the Institution of Civil Engineers, Vol 24, 1864-65, p 369 (Fox on his recommendations).
   c. Vol 56, 1878-79, p 79 (Fitzgibbon speaking to a paper).
   d. Vol 89, 1886-87, p 466 (Fitzgibbon's obituary).


9 Australian Railway Historical Society Bulletin, various.


11 C.F. Dendy marshall:
   (a) A History of British Railways Down to the Year 1830, Oxford University Press, 1938
   (b) Two Essays in Early Locomotive History, 1928.


References on the beginnings of other medium gauge railway system have also been consulted.