7 The Technical & Social Significance of the Tricycle

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It is generally accepted today that the tricycle is a three-wheeled sub-species of the bicycle, used by children, people with disabilities, seniors living in retirement communities, and by a tiny minority of road racers who are viewed by mainstream cyclists as eccentrics. As Derek Roberts has observed, today the "barrow" is an object of considerable ridicule.[1] Indeed, aside from Derek Robert's excellent technical description (in seven parts) "The Development of the Tricycle," I am not aware of any comprehensive historical account focusing on the tricycle.[2]

In the cycling literature, the tricycle is usually presented as a story that flows out of the main narrative concerning the bicycle, rather than the reverse. But is it? Would it be heretical to suggest that the bicycle is a variant of the tricycle? If we turn the clock back to the dawn of the cycling era, the tricycle, in the form of the pilentum, was already a machine propelled mechanically by its rider,[3] while the draisine and hobby horse were simply walking machines.[4]

Thomas Revis's treadle-driven Aellopodes tricycle was causing a stir in Cambridge in the years after 1838, and so pre-dates the Scottish treadle-driven bicycles.[5] Nick Clayton describes a number of three- and four-wheeled British velocipedes dating to the 1860s, noting that, "the whole East-Manchester area, somewhat like Dumfries in Scotland and Cambridge in the Fens, was a pocket where velocipedes were in regular use before the two-wheeler appeared."[6] There is also a troublesome report from Lacy Hillier, stating, "The direct pedal action of a crank on the front wheel was first applied to a tricycle by Messrs Mehew of Chelsea and the machine was shown in the [London International] exhibition of 1862. It seems probable it was seen there by an ingenious Frenchman named Pierre Lallement."[7] In the 1860s the velocipede had appeared as both a bicycle and a tricycle.

Again, little is said in histories of cycling about the tricycle boom that took place in the early 1880s, yet during this boom the tricycle vied with the bicycle for the interest it attracted, and for its

economic and social significance. In the Introduction to his *1882 Tricyclists' Indispensable Annual*, Henry Sturmey wrote:

> When I set forth the first edition of this work last April, I did not anticipate a failure, neither did I on the other hand anticipate such a wonderful success as it turned out to be.
>
> The fact of the entire edition having run out of print in three weeks, and the demand continuing for months afterwards … I feel that I have little, if any, apology to offer for producing a second edition.
>
> The rapid strides in the pastime of tricycling, and the use of this now popular vehicle for business purposes, have of late made, together with the recent wonderful multiplication of patterns of the machine itself, and the consequent development and rapid increase of the manufacturing trade in this direction, all tend to show that the subject is one both of interest and importance …[8]

A separate magazine devoted exclusively to the tricycle, *The Tricyclist*, edited by Lacy Hillier, was published from 30 June 1882 until 2 October 1885, after which it was incorporated with the *Bicycling News*. The authoritative Henry Sturmey wrote separate *Indispensable Handbook* Annuals for the Tricycle in 1881, 1882, 1883 and 1884, while the Stanley Shows in the early 1880s gave almost equal attention and space to the bicycle and tricycle. Griffin of 1886 devotes 60 pages to the bicycle, and 89 pages to the tricycle. In the 1887 (first edition) of the Badminton Library series on Cycling, construction of the bicycle receives 55 pages, and of the tricycle 51 pages, so they are treated as vehicles of almost equal importance.

As early as 1869 when the velocipede had become the rage, two authors were predicting a great future for the tricycle. J.F. Bottomley-Firth wrote:

> The great advantage which in the eyes of many people, the tricycle possesses over the two-wheeled velocipede, is the comparative safety which ensures it from overbalancing.

He continues:

> After all the Tricycle is a very useful machine, and it is by no means impossible that after the present rage for speed and style has passed away, its merits will receive still wider recognition.
>
> To the artizan (sic) and trader, or even to professional men, who may leave suburban houses early in the morning, the tricycle will no doubt recommend itself, in preference to its swifter brother. It enables them to carry considerably more luggage, and also if they think fit, they may on a wet day, avail themselves of an umbrella.
>
> Velox opined that: "In all probability the three-wheeled velocipede will have a more enduring and widespread popularity than the two-wheeled," stressing that tricycles are not particularly safe, but they do balance easily, and can serve as a seat when stationary.[9]

Clearly, I do not want to overstate the case for the tricycle, especially in view of its gradual eclipse by the bicycle after the mid-1880s, but I do argue that the tricycle is a vehicle of considerable historical significance in its own right, and that a better understanding of the development and social significance of the tricycle will usefully complement the history of the bicycle. In order to set the stage, I will begin by summarizing the four claims I make for the tricycle.

The significance of the tricycle

Of the various claims that could be made for the importance of the tricycle as an artefact, I think four stand out:

1. The tricycle was a highly successful innovation in its own right, giving rise to the tricycle boom of the early 1880s.

2. In the early 1880s the tricycle succeeded in attracting a wide range of riders, both male and female and young and old. This prompted inventors and manufacturers to search very hard for a new form of bicycle that provided a safer alternative to the highwheel bicycle so that they could expand their market beyond its restricted

cohort of young and athletic male riders. It was, therefore, a harbinger of the mass-consumption of cycling in the 1890s during the era of the safety bicycle.

3. The tricycle was a machine of considerable technical significance, with several key breakthroughs in vehicular technology in the late 19th century, initially applied to, or developed for, the tricycle. The automobile, in particular, is much more a descendant of the tricycle than of the bicycle. Or, to turn the perspective around, to grasp the origins of the automobile, one needs to excavate the tricycle era.

4. The tricycle provided the beachhead for women cyclists, establishing their presence in public spaces as cyclists. Within a few years, following the advent of the safety bicycle, streets and parks were recognized as spaces that male cyclists had to share with women cyclists and with the values that women brought to cycling.

The Tricycle Boom

The dates of the tricycle rush have not been formally agreed upon, but I suggest the years 1880 to 1886. Sturmey, who had as good antenna for detecting cycling trends as anyone, published his first *Indispensable Handbook* for tricycles in 1881, so there can be little doubt that there had been sufficient groundswell of interest in the tricycle by the summer of 1880 for him to compile a separate guide for tricyclists during the following winter and to publish it in April of 1881.

As for the end of the boom, the year 1886 suggests itself since in the previous year Sturmey had devoted his *Handbook* to the "Safety Bicycle," with extensive coverage of the Kangaroo and its many variants, as well as Starley and Sutton's first Rover machines which, by 1886, were commanding considerable consumer interest. These new safety machines offered older and less athletic male riders a less risky alternative to the highwheel bicycle, but one that was less ponderous than the tricycle. Interest in tricycles also remained strong throughout the 1880s, with the fast and light front-steering tricycle—the Humber Cripper—making its first appearance in 1886.[10] Lightweight Cripper-style machines gave an impetus to tricycle racing, and adult tricycles remained a popular alternative to the bicycle into the 1890s. For women, there was still really no alternative to the tricycle until improved versions of the safety bicycle appeared in the late 1880s.

What triggered the tricycle boom? Many historians of technology attribute this to technological breakthroughs by talented inventors, in so doing stressing inventors and producers as the main source of technological change. In contrast, the SCOT school of sociologists led by Trevor Pinch and Wiebe Bijker stress larger social processes, and especially consumers who create demands for particular artefacts with particular characteristics that guide the direction of innovation.[11] I made an argument at the 15th ICHC Conference in Vienna in 2004 for understanding technology as geographically constructed.[12] By this I mean that both producers and consumers can contribute to technological innovation, especially in regions where they are geographically concentrated in a way that fosters interaction between makers and users.

This is most likely to occur during the early phase of rapid product development. In the age of microprocessors, Silicon Valley is the archetype of this. I adopted the acronym G-COT (geographical construction of technology) to represent this idea, and to illustrate the argument used the example of Coventry in the 1869–1880 period, when the city's bicycle industry rose from nothing to become the world's largest centre of bicycle manufacture. If my argument has any currency, it should also work for the case of the tricycle industry which, like the bicycle, was effectively launched in Coventry.

James Starley played a crucial role in the development of tricycle technology in Coventry. Andrew Ritchie notes: "Starley was the first inventor to put a tricycle successfully into production, and did more than any other individual to advance and develop it subsequently."[13] By patenting the successful Ariel high bicycle in 1870, James Starley and William Hillman effectively launched the highwheel era in Britain. Seven years later, Starley succeeded in developing not one, but three quite

distinct vehicles. In March 1877 Starley launched the Coventry Lever Tricycle using Haynes and Jefferis as the sub-contractors to manufacture this machine (which he and John Kemp Starley had patented the previous year). The Coventry Lever tricycle subsequently evolved into the Coventry Rotary tricycle, arguably the most novel and distinctive of all the tricycles. Two months later, Starley added another large wheel and crank to turn the Lever tricycle into a sociable quadricycle, which (re?) launched the era of sociable riding: a man could now take his lady out for a spin in the park. Then in September, he launched the Salvo Quadricycle which incorporated two major technical innovations: a "balance gear" (i.e a differential on the rear axle), and rack and pinion steering. The Quadricycle's rear wheel was soon reduced to a small tipping wheel which only engaged the ground when the machine tipped backwards, thereby creating the Salvo tricycle. Ritchie adds:

> The Salvo was a major breakthrough in bicycle design, and the first really successful machine … It was a remarkable machine, and one of the key machines in the history of cycling technology."[14]

A number of other key tricycle designs were developed in Coventry during this era. Bayliss Thomas's Excelsior tricycle pioneered the open front, or hayfork, tricycle with rear steering, of which the Coventry Machinists's Cheylesmore tricycle became the best known. These were chain-driven tricycles, some with single chains, and others with double chains and clutches. In contrast, the Caroche and some versions of Starley and Sutton's Meteor tricycle were gear-driven variations on the open front. George Singer's Challenge tricycle, patented in 1877, presented users with another interesting, though rather complicated, tricycling alterative, again with a Coventry pedigree (Singer, like Starley, had formerly been employed at the Coventry Machinists Company, the pioneering cycle manufacturer in Coventry). In 1878 John Marshall Starley and John Kemp Starley patented the folding Compressus tricycle, and in the years that followed a series of tricycle-related inventions of varying importance came from the many cycling manufacturing firms located in Coventry.

The first large-scale tricycle makers became established in Coventry before the tricycle boom took off. Starley Bros, created by the sons of James Starley in 1878, was the first maker exclusively of tricycles, but other firms specializing in the tricycle soon followed. Starley & Sutton (founded in 1879) focused mainly on the Meteor tricycle in its early years, while the Caroche Tricycle Company of 1880 was also a tricycle maker of national importance. Haynes & Jefferis & Co. (makers of both bicycles and tricycles) was purchased by George Woodcock in November 1878, and was renamed the Tangent & Coventry Tricycle Co. in 1879. Of the ten tricycle makers listed in Sturmey's *Indispensable* of 1878, eight were located in Coventry, and the other two in Dublin (manufacture of the Dublin tricycle was transferred to Hillman & Herbert of Coventry the following year). As the tricycle boom gathered steam, dozens of smaller makers emerged so that by 1882 Sturmey listed 164 models, although the major makers were still overwhelmingly based in Coventry.

The preceding remarks might suggest that makers and inventors were central to the tricycle project. But the G-COT approach also recognizes the importance of users and potential users who stimulate makers to muse about tricycles, and guide them in particular directions in a few favourable locations. And in a city like Coventry, the makers were also users, indeed the iconic photograph of James Starley presents him seated on a Salvo tricycle in Club uniform. Most makers were active in local bicycle clubs where other users must surely have made numerous remarks, both critical and constructive, about the tricycles they rode.

The tricycle boom appears to have had its biggest impact in Britain, but its impact reverberated around the cycling world. The leading American makers, Columbia and Overman, launched a series of tricycles, although interest in tricycling in the U.S. appears to have been lower than in Britain. Canada and Australia also were caught up in the tricycling rush, but seemingly to a lesser extent than in Britain, perhaps because roads were worse and urban parks fewer in number.

A Harbinger of the Mass-Consumption of Cycling

During the early years of the ordinary bicycle, few serious riders questioned the multiple risks associated with riding and racing these machines, nor was safety the overriding priority. As Clayton notes:

> What riders wanted in 1879 was faster, lighter and more mechanically reliable ordinaries. Safety was certainly not at the top of any Club rider's demands. For those who wanted safety, there was always the tricycle. Tricyclists were a lesser breed.[15]

Gentlemanly conduct was also expected of club cyclists; groaning and grumbling about accidents and spills was considered poor form, whereas making light of crashes demonstrated that the Clubman was a good sport. Riders frequently trivialized what appear to have been quite serious accidents. For instance, Norcliffe describes the cavalier attitudes displayed by members of the Montreal Bicycle Club on a number of occasions during the early years of Canadian cycling, including the following report on a Club race held on 14 July 1881:

> Tibbs fell in the first lap and Miller performed the great double somersault act over him and both retired as gracefully as possible under the trying circumstances."[16]

Having witnessed a comparable accident where both riders were hospitalized, I think we have to recognize the high risks associated with riding the highwheel bicycle, especially on the poorly maintained roads of the period. By the early 1880s cumulative evidence of the dangers of the ordinary bicycle was becoming apparent, and increasingly difficult to dismiss. Regular reports of serious accidents and fatalities in newspapers and journals, critical judgements from coroner's inquests, and the tragic circumstances faced by a handful of widows slowly raised public awareness of the risks of wheeling. As Bijker argues, in due course, this gave rise to a discourse concerning the need for a safer bicycle: he notes that women wanting to cycle could avoid the risks of the ordinary bicycle by using a tricycle.[17] A number of women seized the opportunity to engage in the fashionable new sport, despite the high cost and large space required to store these tricycles, thereby demonstrating to inventors and manufacturers that a large new market could be tapped if a safe two-wheeler were developed. It was the tricycle that demonstrated that women were potentially as large a market as men, and key to the boom in social cycling a decade later. During the tricycle boom men, too, due to age, heredity, or injuries that made them less nimble than their highwheeling peers, were able to engage safely in the fashionable sport of cycling on three wheels. A significantly larger constituency of male cyclists could also now participate in the sport.

The Technical Significance of the Tricycle

There are a number of technical problems common to the bicycle and the tricycle. How do you propel the machine—by chain, cranks, drive shaft, levers, or by foot? How are the wheels constructed, and with what kind of tiring? What material is the frame made of—wood, solid metal, tubing, plastics or wire? Does it have a seat or a saddle? The tricycle, in addition, poses two unique technical problems:

1. Given the three wheels, how do you steer the machine?

2. How do you make the vehicle go round a corner which, by definition requires the wheels to rotate at different speeds depending upon the arc of the radius they define when turning.

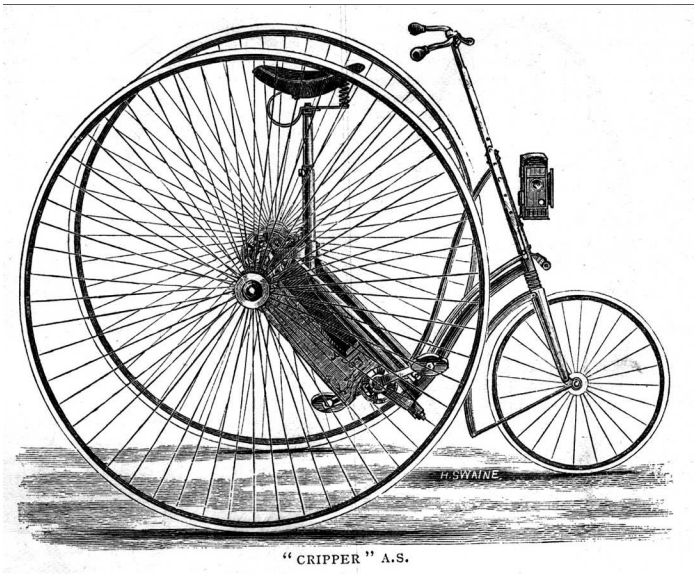
1. Steering

The machines made in the 1870s and 1880s demonstrate that a tricycle could be steered in several ways. The earliest of tricycles—the Pilentum, used indirect front steering (and front-drive) while many of the velocipede tricycles of the late 1860s used direct front steering. After the commercial

introduction of the Cripper in 1886, direct front steering rapidly became the norm, and has remained the case ever since. So the steering of modern tricycles is similar to those of the earliest tricycles, but in between inventors experimented with a number of variants.

A. Side Steering: the Coventry Rotary

In many ways the Coventry tricycle—developed by James Starley—was the most ingenious of them all. Two small steering wheels in line on the right hand side of the tricycle were balanced by one large wheel in the centre of the left side. The two steering wheels pivoted in the opposite direction, thus describing the arc of a circle when activated. In the earlier Coventry Lever Tricycle, a steering tiller was attached to the front forks, and long rods connected the front forks with the rear forks so that when the front wheel was turned to the left, the rear wheel turned to the right, and vice versa. In the later Coventry Rotary tricycle the levers were replaced by a chain, and the steering handle was placed next to the rider and connected to the two steering wheels by a rack-and-pinion system.



"CRIPPER" A.S.

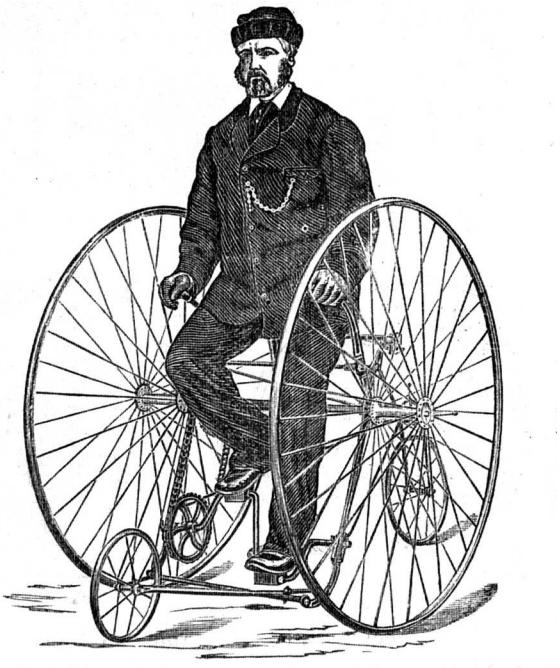
B. Indirect Front Steering: the Loop-Frame Tricycle

Not content to launch one new tricycle in 1877, in September 1877 James Starley launched the Salvo Quadricycle—which soon saw its rear wheel reduced to a tipping wheel to make it a true tricycle. Widely copied by other makers, the loop frame was the most popular of the large tricycles of this era, and got an added boost in the 1880s when Queen Victoria ordered two, allowing the name change to Royal Salvo. The Salvo and similar models were front steerers using a rack and pinion system.

C. Indirect Rear Steering: the Open-Front or "Hayfork" Tricycle

The Excelsior, made by Bayliss, Thomas appears to have been the first open front tricycle. Hayfork

THE RUDGE "TANDEM."



Above: Fig. 7.1. The Cripper tricycle.

Left: Fig. 7.2. Coventry Rotary.

Right: Fig. 7.3. Loop-frame tricycle.

tricycles were almost as popular as the loop frame in the early 1880s, with the CMC's Cheylesmore tricycle and Starley & Sutton's Meteor following this configuration. They were steered by a rack and pinion system connected to the rear wheel. With this layout, they were precursors to the fork-lift truck and other rear steering vehicles.

2. Turning

Turning a tricycle requires the wheels to rotate at different speeds. Several solutions were found to this problem. The simplest solution, and the most common because it was the cheapest, was to use a single driving wheel—but it was not a good solution. It directs the work of the rider to one wheel which may cause slipping, and where one of two rear wheels is the driving wheel, this throws the tricycle to one side, increasing the resistance to the rider. The key solution for rear wheel machines was James Starley's balance gear, or differential, which directed power to both wheels but allowed them to rotate at different speeds. Another solution was found on some Cheylesmore models which had a clutch, allowing the rider to disengage the drive to one wheel when turning. Finally, the side-steering of the Rotary tricycle presented an entirely different approach with the two side wheels describing the turning arc.

The earliest automobiles were developed largely on the platform of the tricycle. Makers soon moved on to a four-wheel platform because tricycles could not withstand engine vibrations and stresses, but the earliest automobiles, both steam- and petrol-driven, were commonly constructed on a tricycle frame. And several key tricycle innovations were carried forward to the automobile so that their makers already had some key technical issues solved. In particular the differential axle, rack and pinion steering, and clutch drives were invaluable techniques for early automobile manufacturers.

A beachhead for women cyclists

Although it was overwhelmingly men who participated in the velocipede craze that erupted in Europe in 1869, images and newspaper reports indicate that a small number of women rode this conveyance, particularly in France. Virtually no women, however, made the subsequent transition to the highwheel bicycle. Perhaps in response, as early as 1872, Starley had invented a lever-driven version of the Ariel highwheel bicycle that women could ride sidesaddle. Although a technical and commercial failure, this curious version of the Ariel was an indicator of Starley's early attempt to make cycling accessible to women. He was evidently aware of women's interest in becoming cyclists. He realized this objective with the tricycles he developed in the next few years. This powerful

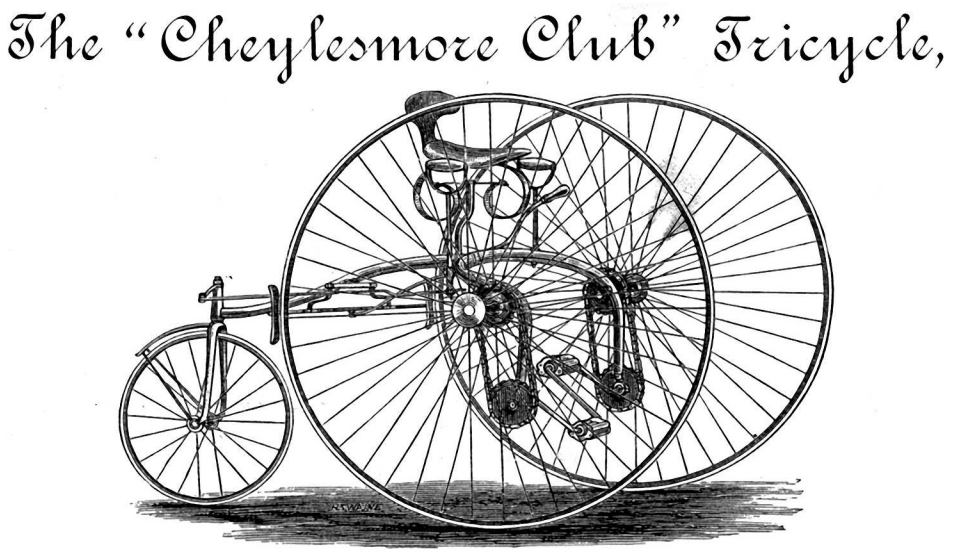


Fig. 7.4. The Cheylesmore Club tricycle is an example of the open-front tricycle design.

connection between women and tricycling is confirmed by the Badminton Library book on cycling published in 1886: the title chosen by its authors for the chapter on tricycling (chapter IX) is *Tricycling for Ladies*, implying that men play a minor role in the world of tricycling.[18] Bury and Hillier write:

> The bicycle was of necessity a solitary vehicle, and still more, a man's vehicle. The tricycle from its first advent, as a practical conveyance, attracted the attention of the ladies.[19]
>
> …The advantages of the sport became more and more patent to its feminine votaries, and their example was followed until at the present there are thousands of lady riders who enjoy more or less the pleasure of a spin upon the tricycle.[20]

It is also significant that Andrew Ritchie adopts the title "Tricycling and 'Sociable' Cycling" for his chapter examining the tricycle: tricycles heightened public awareness of the possibility that two people, usually a man and a woman, might cycle together.[21] Roughly one third of tricycles sold in the 1880s were sociable or tandem tricycles, mainly ridden by courting and married couples. Elizabeth Robbins Pennell provides a good example: wife of one of the leading artist-cyclists of the era, she described a trip she and her husband took on a tandem tricycle in Italy in an article that was widely read by the cycling fraternity.[22]

Women tricyclists also demonstrated that they could achieve physical feats comparable to those of men, thereby firmly pushing back the social barriers to women cycling. None had a bigger impact, in this respect, than Mrs Ada Mason. In May 1883, Mrs Mason covered 102 miles in under twenty-four hours—including 16.5 hours riding time—on a Royal Mail two-track, front-steering tricycle.[23] She rode on normal roads starting in Liverpool, and passed via Warrington, Knutsford, and Holmes Chapel, before reaching the half-way mark at Newcastle in Staffordshire, and returning by the same route. The reporter added: "the performance of Mrs Mason should encourage those of our fair readers and riders who fear a short spin, to try if they cannot, by steady and regular work, even achieve such a feat as that which we this week chronicle."[24]

The tricycle's impact on women's cycling was not limited to the physical distances that women could evidently cover. Awareness of dress codes, and challenges to them, began a decade earlier than is often stated. An editorial of 1883 presents a

Above:: Fig. 7.6. Medal awarded to Mrs. Ada Mason.

Left: Fig. 7.5. The De Dion Bouton.

favourable discussion of the divided skirt, suggesting that it is a compromise between Ottoman, Moorish, and Japanese costumes: by suggesting that the divided skirt is acceptable in several other cultures, they were easing public opinion into accepting women riding in more rational clothing.[25]

Conclusion

The current role of the tricycle as a child's toy belies its historical significance as a conveyance. The tricycle came before the bicycle and in some respects the bicycle is a variant of the tricycle. Its development triggered a tricycle boom in the early 1880s which attracted a much wider range of consumers to cycling than the highwheeler, and demonstrated that both women and older men could be engaged in the sport of cycling if makers could satisfy the demands of these classes of users. So its success spurred makers to search for safer a bicycle. It provided a major platform for the development of the automobile. And its success in attracting a small cadre of society women to the world of cycling was the harbinger of women's mass cycling in the 1890s.

Endnotes

1 Derek Roberts, "The development of the tricycle—Part 1," *The Boneshaker*, Vol 4, No. 33 (1963), p. 23.

2 Derek Roberts published a series of seven reports on the technical development of the tricycle: "The development of the tricycle—Part 1," *The Boneshaker*, Vol 4, No. 33 (1963), pp. 23–33; "The development of the tricycle—Part 2," *The Boneshaker*, Vol 4, No. 34 (1964), pp. 34–45; "The development of the tricycle—Part 3," *The Boneshaker*, Vol 4, No. 35 (1964), pp. 46–56; "The development of the tricycle—Part 4," *The Boneshaker*, Vol 4, No. 36 (1964), pp. 1–12; "The development of the tricycle—Part 5," *The Boneshaker*, Vol 4, No. 37 (1964), pp. 13–25; "The development of the tricycle—Part 6," *The Boneshaker*, Vol 4, No. 38 (1965), pp. 26–38; "The development of the tricycle—Part 7," *The Boneshaker*, Vol 4, No. 39 (1965), pp. 39–47.

3 Roger Street, "The precocious Pilentum," *The Boneshaker*, Vol. 17, No. 168 (2005), pp. 26–31.

4 Roger Street, *The Pedestrian Hobby-Horse* (Christchurch, Dorset: Artesius Publications, 1998).

5 Roger Street, "Thomas Revis and his Aellopodes tricycle," *Cycle History 13: Proceedings of the 13th International Cycling History Conference*, edited by Nick Clayton and Andrew Ritchie (San Francisco: Van der Plas Publications, 2003), pp. 136–141. The Aellopodes (storm-footed) first appeared in 1838, and a few models appear to have been ridden around Cambridge up to 1857.

6 Nick Clayton, "James Hastings and the High Peak Velocipede Club," *Cycle History 16: Proceedings of the 16th International Cycling History Conference*, edited by Andrew Ritchie (San Francisco: Van der Plas Publications, 2006), p. 70.

7 Lacy G. Hillier, "Cycles past and present," Transactions of the Royal Scottish Society of Arts, Vol. 13 (1892), p. 249. I use the word "troublesome', having read Nicholas Clayton, "The missing link—the search for the origins of the pedal crank," *The Boneshaker*, Vol. 18, No. 171 (2006), p. 18–19. Clayton notes that in Hillier's earlier reports on this machine he does not make the connection with Lallement. And we have still not found a contemporaneous account of what LaRoche and Mehew's velocipede looked like. This matter remains one of the more important missing links in the technical history of cycling.

8 Henry Sturmey, *Tricyclists' Indispensable Annual*, 1882 (Coventry: Iliffe, 1882).

9 "Velox', *Velocipedes, Bicycles and Tricycles: How to Make, and How to Use Them*. (London: Routledge, 1869), p. 59.

10 Andrew Ritchie, *King of the Road: An Illustrated History of Cycling* (London: Wildwood House, 1975), p. 116.

11 Some of the key contributions include: Trevor Pinch and Wiebe Bijker, "The social construction of facts and artefacts: or how the sociology of science and the sociology of technology might benefit each other," *Social Studies of Science*, 14 (1984), pp. 399–441. Wiebe E. Bijker, *Of Bicycles, Bakelite and Bulbs: Toward a Theory of Socio-technical Change* (Cambridge Mass.: MIT Press, 1997); Nellie Oudshoorn and Trevor Pinch, *How Users Matter: the Co-construction of Users and Technologies* (Cambridge Mass: MIT Press, 2003); Paul Rosen, *Framing Production: Technology, Culture and Change in the British Bicycle Industry* (Cambridge, Mass: MIT Press, 2003).

12 Glen Norcliffe, "The rise of the Coventry bicycle industry 1869–1880, and the geographical construction of technology," *Cycle History: Proceedings of the Fifteenth International Cycle History Conference*, edited by Rob Van der Plas (San Francisco: Cycle Publishing, 2005), p. 41–58.

13 Andrew Ritchie, note 10, p. 104.

14 Ibid, p. 107.

15 Nicholas Clayton, "The quest for safety: What took so long?," *Cycle History 8: Proceedings of the 8th International Cycle History Conference, Glasgow, Scotland*. (San Francisco: Van der Plas Publications, 1998), p. 17.

16 Glen Norcliffe, "Associations, modernity and the insider-citizens of a Victorian highwheel bicycle club." *Journal of Historical Sociology*, Vol. 19 (2006), pp. 121–150.

17 Bijker, op. cit. note 11, p. 43.

18 Viscount Bury and G. Lacy Hillier, *Cycling* (London: Longmans, Green, and Co, 1887).

19 Ibid, p. 266.

20 Ibid, p. 267.

21 Ritchie, note 11.

22 Joseph Pennell and Elizabeth Robbins toured Italy in 1885. See Elizabeth Robins Pennell "Italy, from a Tricycle" *The Century*, 31(5), Mar 1886 and *The Century*, 31(6), April 1886.

23 Anon. *The Tricyclist*, Vol.1 No. 48, 25 May 1883, p. 571.

24 Ibid., 571.

25 Anon., *The Tricyclist*, Vol.1 No. 48, 25 May 1883, p. 577.