

- 48 See Terrane, *Die Wettbewerbsfähigkeit*, 58-67; Fabian, *Produktionstechnischer Fortschritt*, 335-377; Michael Breitenbacher, *Textilindustrie*, 2nd rev. ed. (Berlin: Duncker & Humblot, 1971), 105-106; Peter Sass, *Die Finanzierung der Investitionen in der Textilindustrie* (Münster: Forschungsstelle für Allgemeine und Textile Marktwirtschaft, 1970), 5-6.
- 49 OECD, *Industrial Revival Through Technology*, 101.
- 50 See Brian Toyne et al., *The Global Textile Industry* (London: Allen & Unwin, 1984), 43-44.
- 51 See Stephan H. Lindner, *Dan Fodens verloren. Die westdeutsche und die französische Textilindustrie auf dem Rückzug (1930/45-1990)* (Münich: Beck, 2001) 92-109.
- 52 *Ibid.*, 109-120, 137-145; on the adventuring of 1978 see 139.
- 53 See Vinod K. Aggarwal, *Liberal Protectionism: The International Politics of Organized Textile Trade* (Berkeley: Univ. of California Press, 1985); Donald B. Keating and Martin Wolf, *Trade Gains Against Developing Countries* (London: Trade Policy Research Centre, 1980); Jürgen Wiemann, *Schärfster Protektionismus und akute Struktur Anpassung. Handels- und industriepolitische Reaktionen Europas auf die zunehmende Wettbewerbsfähigkeit der Entwicklungsländer - dargestellt am Beispiel der Textilpolitik der EU* (Berlin: Deutsches Institut für Entwicklungspolitik, 1983).
- 54 Peter Temu, "The Relative Decline of the British Steel Industry, 1880-1913," in Henry Rosovsky, ed., *Industrialization in Two Systems: Essays in Honor of Alexander Gerschenkron* (New York: Wiley, 1966), 140-155.
- 55 "China Mills Close a Chapter: Textile Workers Who Spun Revolution Lose Jobs" (by Edward Cody), *International Herald Tribune*, Zürich (6 Jan. 1997).
- 56 See Rainer Föbel, Jürgen Hennrich, Otto Kreye, *Umbuch in der Weltwirtschaft. Die globale Strategie: Verbilligung der Arbeitskraft/Flexibilisierung der Arbeit/Neue Technologien* (Reisebuch near Hamburg: Rowohlt, 1986), 103-106, 181-187.
- 57 Allix and Gilbert, *Géographie des Textiles*, 339-340, quotation on 340: "tout que d'une maine ou de l'autre les vieux pays manufacturiers aient livré comme Samson le secret de leur force."
- 58 United Nations, *Economic Survey of Europe*, 192.
- 59 Stephan H. Lindner, "Der lange Abschied vom Textilland Voralberg," *Alemannia Studiens* 7 (1997), 55-57, here 85.
- 60 Interviews with two top managers of Dierig, Augsburg; Mr. Vessyren, chairman, and Dr. Kampen, technical director, 27 and 28 June 1996.
- 61 Friedrich Aumann, "Auswirkungen der Osterweiterung der EU auf den Produktionsstandort Deutschland für Textilien und Bekleidung - eine empirische Analyse zu Stand und Trends," in Roland Döhn, ed., *Osterweiterung der EU - Neue Chancen für Europa?* (Berlin: Duncker & Humblot, 1998), 51-73.

## Production and Culture in the Global Cycle Industry

Paul Rosen

### Introduction

The increasing attention paid to globalisation by social theory arises largely out of a growing concern with space and spatialisation that has developed within debates around modernity and postmodernity. Discussions of globalisation within sociology have consequently followed for the most part the cultural focus of these debates.<sup>1</sup> However, the introduction of a spatial dimension to how we approach the shift from modernity to postmodernity offers an opportunity to broaden our understanding of how the production and consumption of goods has been changing in ways that are multidimensional – they are simultaneously social, cultural, economic, political, technological and spatial. Economic and political changes in the late 20th century have combined with innovations in communication technologies to allow firms and industries that were once more firmly rooted within their home markets to spread production across the globe in order to pursue cheap labour and reduced regulation. At the same time, commentators argue, the globalising culture of postmodernity often makes it possible to sell these global products to a "de-differentiated" world consumer market – the "global car" being the most commonly cited example of this.<sup>2</sup>

How accurate, though, are such accounts of global change? Are the shifts that have taken place as straightforward as is commonly portrayed? Several writers have questioned whether globalisation is truly global, in the sense of affecting all parts of the world equally. It is argued that what has actually taken place is simply a reconfiguring of international economics that follows existing patterns in albeit new and more intense forms.<sup>3</sup> Similar questions might be applied to "global" consumer culture. To what extent are the changes in American or British culture that so often shape sociological thinking a valid account of other parts of the developed, or even more so, the developing worlds? And however accurately a concept such as the global car represents changes in that one product, does it apply equally for other products, other industries and other markets? The history and sociology of technology tell us that the contingencies and uncertainties of change make this very unlikely. The story of any one product is shaped through the interactions of numerous factors in the product "lifecycle" – from conception and design, through production and distribution, to consumption and use. The globalisation of these

processes makes the social shaping of technology far more complex than is the case in many accounts of technological change. It is worth asking, then, what form – if any – globalisation takes in particular industries and with particular products. What factors enable or prevent the more intensified internationalisation or globalisation of certain aspects of the product lifecycle? What role do the different components of change – social, cultural, technological, economic – play in bringing about this shift? And do such stories offer any lessons for mitigating the negative impacts of global change, especially for those areas of the globe which suffer the costs of globalisation but rarely see the benefits?

In this chapter I will examine these issues with regard to the changing fortunes of the British bicycle industry, taking the perspective of the social construction of technology approach within the sociology of technology. The organisation and methods of production of the bicycle industry interact not just with the nature of the goods produced but also with the culture of consumption that forms around those goods. More broadly, production changes in industry have generally over the 20th century been heavily implicated in the progression of modernity through to what is commonly regarded as postmodernity; globalisation is considered to be a central aspect of these changes, and this is clearly evident in the case of the bicycle. Before looking in more depth at this case, I will first outline the relationship between technology and production on the one hand, and modernity, postmodernity and globalisation on the other.

### Modernity and Postmodernity

Technological change is seen as integral to the intensification of modernity that took place in the 19th century. New technologies of power, travel, manufacturing and communications brought about a changing experience of the world, a shrinking of time and space, and newly globalised economic, political and social relations.<sup>4</sup> Marshall Berman vividly depicts the ambivalence thrown up by living in this newly modern world, which was at the same time both exciting and extremely threatening. He describes

the highly developed, differentiated and dynamic new landscape in which modern experience takes place. This is a landscape of steam engines, automatic factories, railroads, vast new industrial zones, of teeming cities that have grown overnight, often with dreadful human consequences; of daily newspapers, telegraphs, telephones and other mass media, communicating on an ever wider scale; of increasingly strong national states and multinational aggregations of capital; of mass social movements fighting these modernisations from above with their own modes of modernisation from below; of an ever-expanding

world market embracing all, capable of the most spectacular growth, capable of appalling waste and devastation, capable of everything except solidity and stability.<sup>5</sup>

Similar arguments have been made for the late 20th century, notably by David Harvey, who is concerned with the emergence in recent decades of postmodernity and postmodernism.<sup>6</sup> He regards the transformations that have taken place since the 1960s in the organisation of the state, in modes of financial regulation, in production and capital accumulation, and in culture, to be a highly intensified recurrence of the same processes that heralded modernity and modernism. In particular, he highlights parallels between the association of Fordism with modernity in the early part of the 20th century, and an equivalent association between post-Fordism – which he terms flexible accumulation – and postmodernity.

Harvey and others have described how Fordism grew beyond being just a description of mass production, into a set of practices and principles that underpinned most Western societies. The Fordist state, Fordist regimes of capital accumulation, and reinforced Fordist mass production, especially during the post-war years,<sup>7</sup> the collapse of this Fordist consensus since the 1960s has left national and global economic and political structures more fragmented. Mass production has been replaced by flexible specialisation, underpinned by non-specialised equipment that allows manufacturers to respond quickly to fragmented niche markets.<sup>8</sup> The accumulation of capital also has become more flexible, with manufacturers chasing around the globe in search of ever-cheaper labour and lower taxes. The result has been a variety of globalised production processes, including not just the notion of a global product made identically in numerous locations around the world, but also the globally dispersed production of different parts of a final product that only come together geographically at the point of assembly. Accompanying these changes in production have been developments that have reduced the role of the nation state and transferred global economic power from nation states to transnational corporations.

Underpinning these arguments about changing political, economic and cultural relations is an understanding that the temporal concerns of modernity – the assumption of a progression from the traditional to the modern and then the postmodern – need to be augmented by spatial concerns embodied in notions of globalisation.<sup>9</sup> Nevertheless, the associated concepts involved in modernity, postmodernity and globalisation are subject to numerous, often convincing, critiques – for example, questioning how appropriate Fordism and car production are as models for manufacturing in general, questioning the degree to which mass production has really been eclipsed by flexible specialisation, and questioning the ex-

ment to which globalisation has really involved the marginalisation of the nation state.<sup>10</sup>

It is not necessary to rehearse all these debates here, but a common theme worth highlighting is the argument that the processes described by theorists of flexible specialisation, postmodernity and globalisation have in fact been with us for longer than just the last few decades. As noted with Harvey, more recent developments are seen by some as an intensification of long-established processes rather than the emergence of something qualitatively new. Paul Hirst and Grahame Thompson put forward an argument in respect to globalisation that is reminiscent of Harvey's analysis of postmodernity.<sup>11</sup> They question whether there is any valid empirical basis behind the concept of globalisation. For them, the features of the world economy that are commonly labelled globalisation – notably the exploitation of resources and identification of new markets by Western capital at a global scale – have been present for over a century, and have even diminished in some respects. What has changed, they argue, is an internationalisation of the global economy, with new patterns of trading relations centred around three clusters of nations focused on the U.S., Europe and Japan.

One way of trying to understand this kind of transformation on the ground is through Gary Gereffi's concept of *global commodity chains*. This approach has the benefit of allowing an analysis of specific commodities within the context of general trends, and hence overcomes some of the problems associated with theories of globalisation. It does not assume that all industries undergo the same changes in the same timeframe. Gereffi sets out two kinds of global commodity chain: those that are producer-driven, shaped by the strategic investment decisions of transnational manufacturing firms – and akin to the mass production approach; and those that are buyer-driven, shaped by the retailers and branded merchandisers whose orders "mobilise global export networks composed of scores of overseas factories and traders" – and thus more akin to flexible specialisation.<sup>12</sup> Reflecting critiques of the notion of post-Fordism, Gereffi regards these two types of chain not as representing different temporal stages of industrial development. Rather, they are two different trends that are usually associated with particular industries – producer-driven chains tend to be characteristic of more established industries such as heavy engineering, whilst buyer-driven chains are evident more in newer industries including clothing and high technology.

This notion of global commodity chains captures the shifts in international economic relationships that are discussed by writers such as Hirst and Thompson. For both analyses, the degree to which these changes are truly global is less significant than the way in which they reinforce existing economic and political relations. At the same time, they underline the ways in which globalisation has involved a simultaneous strengthening of *locality*, as processes which on the surface are global,

nevertheless take on specific meanings in particular local or regional contexts. The meaning of a global commodity chain varies, for example, depending on your position along the chain. These economic and cultural shifts are not, then, simply global; rather, they take the form of "global localisation" – or "glocalisation" – as global processes become integrated within specific localities.

### Sociotechnical Frames in the Social Construction of Technology

I want to explore debates about globalisation, modernity and postmodernity, and their relationship to technological change, taking the case of the bicycle industry firstly; the interwar years, and secondly, the period from the late 1970s through to the turn of the twenty-first century.<sup>13</sup> These two periods have both involved substantial – and parallel – shifts in production methods, the organisation of the bicycle industry, bicycle design, bicycle usage and the cultural meaning of bicycles. These shifts, which I characterise as transitional phases and globalisation are highly pertinent to different *sociotechnical frames* of bicycle production.

I have adapted the concept of a *sociotechnical frame* from Wiebe Bijker's *technological frames*, a concept which forms a central component of his social construction of technology (SCOT) approach developed with Trevor Pinch. SCOT was first developed as a means of challenging overly technical accounts of technological change. Pinch and Bijker identified the social dimensions of such change, centred around the competing meanings held for any artifact by a range of different *relevant social groups*. It is social processes, they argued, rather than technological ones that lead to the emergence of a single meaning for an artifact – thus the *interpretive flexibility* that characterises many technologies in their early stages is followed by *closure* of meaning, and technological stabilisation.<sup>14</sup>

Having established the notion that technological change is not simply a self-evident technical process but one which is socially constructed, Bijker and others have taken SCOT further, developing a set of concepts which account for how this process plays out in different contexts.<sup>15</sup> For Bijker, technologies are constituted by the interactions which take place around them. These interactions will establish a consensus among different interest groups around how "effective" or "successful" a particular design is. Bijker sees *technological frames* as the settings in which these interactions take place; innovators, industrial designers, marketing people and so on, as well as users or even non-users of the artifact might each have their own technological frame for thinking about and interacting around an artifact. The focus of the interactions that take place within a frame centres especially around the knowledges and practices of the relevant social groups involved. Technological frames

provide, then, the cultural context within which those involved with an artifact – as engineers, manufacturers or consumers – engage with it and with other interested parties.

This SCOT framework has been subjected to critique from a number of directions, not always entirely fairly. The most sustained criticism has concerned the potential of this approach to address questions of power in the social relations of technology, a shortcoming which I believe results more from a lack of attention to this issue in what is still a fairly new field than anything intrinsic to the framework.<sup>16</sup> The conclusion to this chapter shows, I hope, that such inattention does not have to be the case.

A more significant problem is the way that the concepts of SCOT are applied within the framework to particular artifacts in the case studies used. In Bijker's account of the development of Bakelite, for example, he attaches a specific technological frame to each professional activity involved in the emerging story – there is one technological frame for celluloid chemistry, another for electrical chemistry, and a third for Bakelite itself.<sup>17</sup> The same is the case in Eduardo Albar's and Bijker's recent account of a competition to redesign Barcelona in the mid-19th century, the different proposals for the city are aligned with particular approaches to urban design and urban governance.<sup>18</sup> Such an approach works well for the case studies which Bijker presents, since he discusses artifacts – and the social groups concerned with those artifacts – that appear to be quite discrete. In the Bakelite story, especially, the three different fields of celluloid chemistry, electrical chemistry and plastics are distinct in that they were practiced in different laboratories using different methods. Bijker's analysis only touches incidentally on the other artifacts within these laboratories – the plates, the photographic paper, the plant apparatus and so on – since these were not important to the shift he is depicting which resulted in the development of a new product. The Bakelite story as Bijker tells it – as with the stories in many other SCOT accounts – concerns only a small number of clearly distinguishable objects.

What happens, then, when the story one is trying to tell involves a variety of different artifacts, and when the relationship between these artifacts is crucial to how the story unfolds? SCOT is explicitly concerned to blur the distinction between the social and the technical, something which some take even further in their attempts to challenge the primacy that is usually given to human over non-human agency.<sup>19</sup> However, other boundaries tend to be left intact, notably the boundary that establishes one key technology (whether Bijker's Bakelite, Michel Callon's electric vehicles or Bruno Latour's automatic door closers) as the focus of concern. Other artifacts that interact with this key technology in the processes of design and development, production and consumption are, on the whole, forgotten about.

Paying attention to these other artifacts might, though, lead to the opening up of a whole new set of "black boxes" that would problematise this boundary.<sup>20</sup> This

is certainly the case in the realm of production, which requires consideration of how the design of an artifact is shaped by – or influences the shaping of – the equipment used to produce it. A framework that is concerned only with discrete artifacts can present difficulties for understanding the importance of production equipment to the shaping of industrial products. A more appropriate approach might therefore be not to focus – as Bijker and Hinch do – on just the social interactions that shape the development of individual technologies, but instead to consider how *technologies, social groups and cultural factors* cohere together in particular ways to form a *sociotechnical frame* that encompasses a wider range of relationships than just those within and between relevant social groups.

This framework differs from Bijker's in a number of ways. It includes the interactions and activities of social groups that could perhaps appear less relevant from an engineering or design point of view, for example policymakers and activists concerned with particular issues. It includes cultural factors which are not explicitly part of Bijker's account, such as the discourses that underpin interactions around an artifact – for example, discourses around modernity, efficiency or particular pro-

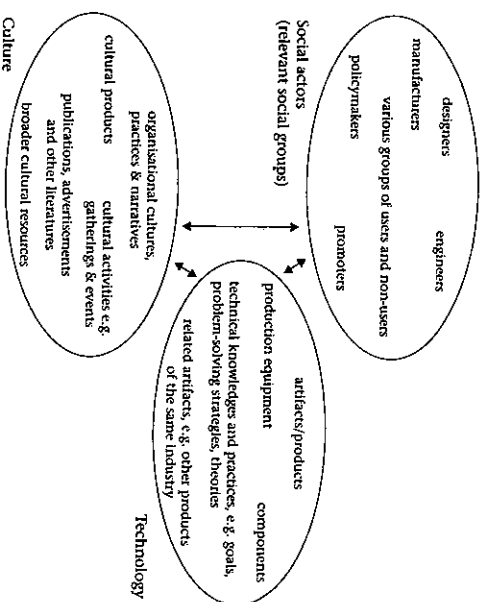


Figure 1: Elements of a Sociotechnical Frame.

duction values – and defining moments in the process by which a particular *sociotechnical ensemble* has become established. For example key sporting events in the history of cycling. It also includes the wider technological context of the specific artifact being studied – such as components or markets shared with other artifacts – and the wider social, political, economic and organisational contexts of the actors involved.<sup>21</sup>

The focus of sociotechnical frames is, then, less narrowly technical than Bijker's concept. It is not focused exclusively on accounting for single artifacts, and it is more heterogeneous in the kinds of things it includes and in whose concerns these things reflect. In short, it brings together a range of interlinked artifacts and components, discourses and practices focused around particular sociotechnical "objects." A further important dimension to the difference between this and Bijker's concept is in terms of how sociotechnical frames relate to each other. For Bijker, several frames can initially cohere around a single artifact over time, one is likely to become dominant (albeit undergoing changes of its own in the process) as the others fall by the wayside. This reflects his view of relevant social groups as the key agents of sociotechnical change. In contrast, change from one sociotechnical frame to another is something that results from a more thoroughgoing shift in the relations among the social, the cultural and the technical. Whilst design flexibility may be indicative of such a shift, it is only one dimension.

I will illustrate these points in the discussion that follows, which is concerned with the sociotechnical objectives of, firstly, establishing mass production methods among British cycle manufacturers during the inter-war years, and secondly the re-placement of mass production with globally flexibilised methods since the 1960s. I will deal with the first of these in the following section.

#### Modernity and Globalisation in the Sociotechnical Frames of the Mass Bicycle

The bicycle was the product of several decades of experimentation with self-propelled wheeled vehicles, beginning around 1817. Over the following decades, a small number of engineers across Western Europe worked on refining what was for the most part a curious plaything for the wealthy, until in the 1860s a small bicycle industry and upper class leisure cycling market became established in France, followed closely by Britain and the U.S. The French lead was curtailed by the Franco-Prussian War of 1870-1871, at which point the English Midlands became the centre of cycle innovation, and the foundation from which the British car industry was to emerge a few decades later. Following several years of rapid innovation and uncertainty over the direction of bicycle design, a period of stabilisation began in the 1890s.<sup>22</sup> The design that resulted formed a central component

of the *sociotechnical frame of the factory bicycle* that then endured into the 20th century.<sup>23</sup>

As cycling became a more widespread pursuit among the upper and upper middle classes in Britain and elsewhere, the leisure-based cycling culture that resulted led to greater sales and an associated predictability of consumer tastes. At the same time, the rapid innovation of earlier decades diminished with the stabilisation of bicycle design around the low-wheeled, pneumatic-tyred, rear-driven safety bicycle. This gave British cycle manufacturers the confidence to begin investing in the up-to-date production equipment already in use in America and Germany. Nevertheless, this early sociotechnical frame was at the same time underpinned by a commitment to craft production – in contrast to the American sociotechnical frame of the bicycle which centred wholly around mass production and consumption.<sup>24</sup> The British industry at this time set great store by the benefits of a craft approach, matching the kind of service valued by consumers. Largely unhindered by machine tools that would later come to set many of the parameters of what was possible in product design, manufacturers at this stage took advantage through innovation, customising, and consequently higher quality and higher priced machines. The craft basis of the industry at this time meant also that labour retained control over what Wayne Lewchuk calls the "effort bargain."<sup>25</sup> In terms of consumers, high prices meant that bicycles continued to be an exclusive product, percolating more fully into the middle classes only when the bicycle boom of the mid-1890s brought down prices and hence increased the bicycle's popularity.<sup>26</sup>

Conceptualising this constellation of bicycles, their riders, their makers and the equipment used to make them as a sociotechnical frame overcomes the difficulty that Bijker's approach would have in trying to account for what might seem less relevant social groups such as craft workers, or closely linked artifacts such as machine tools. This frame was not, though, to be long-lived. The seeds of transformation had already been sown in the 1890s as British companies sent their engineers to America to borrow ideas and to buy new automatic machine tools. Following the end of the First World War, which had enforced reduced outputs as the larger manufacturers concentrated their efforts on munitions, there was a period of some twenty years during which many key elements of the early sociotechnical frame were progressively abandoned. This period involved substantial modernisation of production, borrowing heavily from Fordist methods and from the more flexible version of mass production known as Sloanism. Process innovations and greater standardisation of design resulted in lower prices, and these were reinforced by an expansion of hire purchase. Together, such factors helped to reshape the meaning of the bicycle as a form of everyday transport for the middle and working classes, and no longer as just a toy for the rich.

At the same time, cycling culture retained its love of the pre-modern. Whilst craft methods had been abandoned in practice, they still played an important role discursively, sustaining an image of the bicycle and of cycling that has endured ever since – as a means of escape from the hectic life of the city. Images of rural cycling idylls were and still are common in magazine illustrations and cycle manufacturers' brochures, indicating a long-running theme within cycling culture of an ambivalence towards modernity.<sup>27</sup> Modernity was crucial to cycling culture both as the stimulus that led city dwellers into the countryside, and also as the force that provided them with affordable and well-built bicycles, as well as the metalled roads on which to ride them. This theme played a central role as a key meaning of bicycles and cycling within the *sociotechnical frame of the mass bicycle* which was beginning to be established, coexisting with the bicycle's other prominent meaning that centred around utility-based transportation, for which most bicycles were used during this period.

The mass bicycle was well-established by the late 1930s. Companies such as Raleigh had by this time completed their adoption of automatic production equipment and overhead conveyors, and standardised their product ranges. Nevertheless, the shift from one frame to another did not represent an absolute break. Whilst no longer adhering to the ethos of craft production, management across much of British industry – including the bicycle industry – differed from American counterparts such as Ford's in that they did not take control of the shopfloor. This remained in the control of labour, through a combination of factors. Labour mobilisation in Britain was stronger than in America, and in a better position to resist both the physical threats and the pay incentives used by management at Ford's to control the shopfloor.<sup>28</sup> British management also benefited from the existing system, in the sense that it worked for them as much as for their workforces. To adopt American management methods and hence bring about further industrial strife had no sense at a time when the market could not support the levels of production that Fordism would bring about. So whilst the technology changed, the relations of production of this later sociotechnical frame were little different to those of the earlier one – the systems of foremen and chargehands, piece rates and bonuses established in the preceding decades were retained even as production moved towards increasing automation and standardisation.<sup>29</sup>

A key feature of the mass sociotechnical frame as it became consolidated during the 1940s and 1950s was the centrality of the industry's export markets. This is highlighted by negotiations that took place during the mid to late 1950s between Raleigh and the British Cycle Corporation (BCC), which together owned almost all the major cycle brands of the time. Their shared dominance of the industry was enhanced with Raleigh's purchase in 1957 of the brands owned by BSA, which had been the third main industry player during the preceding decades. During the

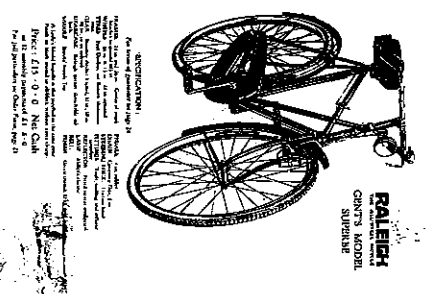


Figure 2. Typical mass production Raleigh – the Gant's Model Superbe, from the 1929 Raleigh catalogue. Copyright: Raleigh Industries.

1950s, Raleigh and the BCC held negotiations over export markets and what might now be called "core products." In order to stem what they realised was becoming a saturated global market. In 1959, for example, Raleigh agreed to close down its South African factory in return for an interest in the BCC's operations there. A few years earlier, discussions broke down over an offer by the BCC to stop producing variable gears in return for Raleigh curtailing its production of either bicycles or steel tubing. Eventually, in 1960, the two companies merged, primarily because of a recognition that they could not continue to compete successfully in global markets that were beginning to develop their own production facilities.

The new company that resulted from the merger retained the Raleigh identity, and became responsible for some 75-80% of UK bicycle output, with around 60% of its production going for export. This new Raleigh's main overseas markets included Nigeria, Iran, and the United States. The kind of product being exported to these countries, just like those sold domestically, is clear from my earlier description of the sociotechnical frame of mass cycle production. They were for the most part fairly heavy/utility or sports bicycles with three-speed gears, available in four key designs with some variation beyond that in styling (see Figure 2). The output of this frame was, then, a de-localised sociotechnology – an artifact that would look the same – however appropriate or inappropriate – wherever it was bought in the world. This blanket standardisation of bicycle design resulted from the constraints set by

mass production, a point made as early as 1933 in a speech made by Raleigh's chairman, Sir Harold Bowden, to the company's agents.<sup>30</sup> Most importantly, it depended on high production levels at Raleigh's Nottingham plant; few overseas facilities were established before the 1950s, and these mainly focused on assembly of imported parts rather than on production.<sup>31</sup> This did not, therefore, bear much resemblance to the kind of global design strategy rooted in flexibility and dispersed production that has been advocated more recently in the car industry.

Whilst very different in form from those that pertain today, global economic and technological relations were central to the socio-technical frame of the mass bicycle. In fact, the British industry's growing dependence on exports developed out of the logic of that socio-technical frame, since the ability to significantly increase production of standardised products generated a need to create new markets. Unfortunately for Raleigh, the decline of its export markets in the 1960s and 1970s also contributed towards the collapse of this frame, and posed a serious threat to the British cycle industry.

### Global Flexibilisation, Postmodernity and Mountain Bikes

Having sketched the global relations of cycle production up until the 1960s, I want to look in more depth at developments that have followed. Just as the conquest by British manufacturers of global cycle markets during the 1940s and 1950s was closely linked to the modernisation of the UK bicycle industry, so too have changing global relations in the industry since the 1970s been linked to flexibilisation and fragmentation, not just in Britain but at a global scale. The changes that have taken place during this period can be regarded as a global flexibilisation of bicycle production, bicycle design, bicycle markets and cycling culture, resulting in a new socio-technical frame of the bicycle. Just as happened with the shift that resulted in the mass bicycle, the socio-technical frame of global flexibilisation again features some continuities with its predecessor alongside many discontinuities.

Most strikingly at a market level, British production no longer accounts for the bulk of domestic sales. Raleigh's production figures dropped steadily from an early 1990s peak of three quarters of a million bicycles (which was itself a significant drop from the 2.8 million produced following the 1960 merger) down to just a few hundred thousand by the end of the decade. The parallel drop in Raleigh's UK market share – from over 75% to less than 30% – has resulted from a transformation of bicycle production and cycling culture globally since the late 1970s. Central to these changes have been the emergence of new production techniques developed outside the traditional centres of production, along with associated changes in management styles, and a particular kind of bicycle – the mountain bike – that has both benefited from and further enhanced these changes. At the same time, the moun-

tain bike has keyed into cultural developments that have served both to transform the meaning of cycling and consequently to revalue it as an activity across much of the developed world. Mountain bikes now account for over 50% of all bicycles sold in the UK, a figure that matches other developed markets, and in many ways they have come to symbolise the global flexibilisation of the bicycle.

The decline in Britain of the socio-technical frame of the mass bicycle involved a number of factors that were already coming into play before the emergence of new production methods and products. One important element was the decline in labour relations, as struggles in the late 1960s between management and the shop-floor resulted in the elimination of piece rates in favour of day rates. Similar developments in the British car industry are seen as crucial in moving more consistently towards Fordism.<sup>32</sup> At Raleigh, on the contrary, this can be seen rather as one of the factors that pushed the company away from its version of mass production, and towards more flexible approaches. This wasn't a straightforward progression, though. Labour struggles continued into the 1970s, culminating in 1977 in a strike that seriously damaged production during the crucial run-up to Christmas, when a high percentage of the industry's annual sales take place. Almost immediately following the resolution of the strike, Raleigh's parent company, TI, began to discuss ways of modernising the factory, beginning with a shift from long conveyors to short assembly tracks staffed by worker "cells." One obvious advantage to management of this shift towards cellular working was in drawing workers into seeing the company's welfare as co-terminous with their own. This was extended with the adoption in the late 1980s of a version of Total Quality Management. This shift in the organisation of production at Raleigh and elsewhere in the UK facilitated the emergence of the new socio-technical frame of globalised flexibility during the late 1980s. The fact that Raleigh came close to closure several times during the 1970s and 1980s, prior to its sale by TI to a group of cycle enthusiast financiers, indicates its likely fate had such changes not been adopted.

As well as labour relations and production methods, Raleigh has also been faced with new kinds of competition and a rapidly changing market since the end of the 1970s. Domestic production began to be challenged in the 1970s by increasing imports that ate into the home market. These came initially from Europe, but from around the mid-1970s the bulk of imports were coming from the Far East – Japan, Taiwan and elsewhere. At the same time, Raleigh's key export markets were one by one closed off – American sales were affected by the strength of the pound, Nigeria cancelled all foreign debts due to an internal economic crisis, and the Italian revolution put an end to its foreign trade. Raleigh responded with a noteworthy transformation of its marketing strategy. It began to look to Europe as a source of potential new sales, duly sponsoring a Tour de France racing team. In 1982, Managing Director Roland Jarvis told *The Guardian*, "we have given up our global ambitions."<sup>33</sup>

In contrast, competitors from the Far East were beginning to realise their global ambitions, based on the successful development of an innovation from California. Mountain bikes developed as a hobby among Californian hippie "bike buffs" in the 1970s, who adapted old balloon-tyred Schwinn children's bikes for fast downhill racing in the dirt tracks of Mount Tamalpais in Northern California. Soon, frame-builders within this group and from the surrounding neighbourhood began to draw on the design of these old machines in building bikes of their own. The term "Mountain Bikes" comes from the name of the company set up by three central participants, Tom Ritchey, Gary Fisher and Charlie Kelly. As they and others were discovering it was possible to sell reasonable numbers of their new California-made product, another approach was being established by the bicycle accessory importer 'Specialized, setting the pattern for the newly emerging sociotechnical frame of the globally flexible bicycle. Specialized supplied a Japanese factory with specifications for its Stumpjumper mountain bike, which it then imported back into the United States. At the same time, mountain bikers' thirst for new components that would be able to withstand the assault that downhill racing put on the bikes brought them to the attention of the innovative Japanese component manufacturers Shimano and Suntour. In the words of Charlie Kelly, this

was the last stage of assembling the infrastructure necessary for mass production, and from that time forward mountain bike production swung into high gear, maintaining for several years the highest growth curve in the bicycle industry...<sup>54</sup> for better or worse, mountain bikes were no longer a garage industry...

The manufacturing process used for mountain bikes was not mass production, though. The boom in mountain bike sales – in the mid 1980s in America, and the late 1980s in the UK – allowed the economies of scale of mass production, but these were combined with a form of flexible specialisation involving global subcontracting and niche marketing. A mountain bike commentator and designer with the British company Muddy Fox – which epitomised this approach as one of the first companies to launch the bikes in the UK – labelled it "remote control manufacturing".<sup>55</sup> He described for me the process of choosing the design and specifications of a mountain bike as follows:

- A. Tubing is selected, usually like the Tange series [a Japanese brand]. Many companies use no-name tubes supplied by factories, often of dubious quality.
- B. Shimano supply "groupsets" [of components], through the Far East factories [sic]. Many companies do not use the full "group" to save money, just utilising the brakes + transmission.

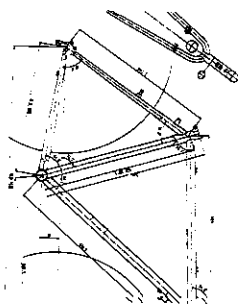


Figure 3: Bike design specification sheet, from photocopy supplied by Hilton Holloway at Muddy Fox (1992).

- C. Frames can be selected of [sic] the shelf, though most detail their own designs.
- D. So the factory will submit a drawing like this [see Figure 3]. It is pretty simple, but suffices for most manufacturers. Better companies will go into more detail.
- E. Ancillary components are selected from a vast catalogue, the "Taiwanese Bicycle Guide."<sup>56</sup>

Design in the new sociotechnical frame of the globally flexible bicycle is thus often a case of picking and mixing pre-existing elements rather than originating new ones, reducing cycle "manufacturers" in many cases to "little more than marketing companies with just an office and a phone."<sup>57</sup> Design innovation has often been left to the trading companies and factories that firms like Muddy Fox deal with in the Far East.

What this means for the British bicycle industry is far more complicated than simply the notion that British manufacturers have lost market share to overseas competitors. The industry has in fact been fragmented and reshaped in quite complicated ways. A significant number of foreign manufacturers are engaged in the UK market – for example the Taiwanese company Giant and the American Trek both have UK offices and market directly in the UK. One interesting twist here was the purchase of Muddy Fox in 1992 by "71 Cycles of India (Raleigh's former Indian subsidiary), which invested in Muddy Fox as a means of gaining access to the British market for its own cheaply produced bicycles – an ironic reversal of its former colonial relationship with Raleigh. In addition to these kinds of relationships, though, an increasingly large proportion of UK cycle firms have adopted the methods I have described to import from the Far East either finished or partly finished bicycles which are then badged locally by the importer. The resulting product is an outcome of complex global relationships – involving designers, framebuilders and compo-



nent manufacturers that can span two or possibly three continents. This global transformation of the industry is likely to continue as cheaper labour markets open up in China, for example – a phenomenon that has already been seen with the shift from Japan to Taiwan as the production centre for mountain bikes.

Such transformations of the organisation of production have been underpinned by the appearance of new manufacturing methods, to which Raleigh's shifts of the late 1970s and 1980s were a partial response. As well as the more obvious economic benefits to flexibly specialist approaches such as short tracks and cellular working, a key feature of the global flexibilisation sociotechnical frame has been the abandoning of traditional methods of brazing together bicycle tubes in favour of a particular form of welding, TIG-welding. This method appears to have travelled to Japan and Taiwan via BMX and then mountain bikes, having originated in the Californian aerospace industry. Its significance lies in the great adaptability it allows for bicycle frame angles, compared to the rigidity of design imposed by mass production methods. It thus caters to a mountain biking culture that is characterised by a burgeoning of ever-more specialist uses that require the minutely differentiated "frame geometries" that are made easy with TIG-welding.<sup>58</sup> More recent developments such as laser cutting of tubes enhance this flexibility, enabling large-scale manufacturers to produce high volumes without the need for standardisation.

This last point highlights a sharp contrast between this and the preceding sociotechnical frame of the bicycle. If the mass frame resulted in global standardisation – and hence de-localisation – of bicycle design, the products of global flexibility are far more complex. Mountain bikes have become ubiquitous, at least in the developed world, to a great extent replacing the utility, touring and racing styles that preceded them. However, the flexibility of production methods that now characterises the bicycle industry means that alongside the globalisation of production and distribution there is more scope for a re-localisation of the meanings of mountain bikes as they spread beyond their Californian origins. This re-localisation takes place largely in the cultural realm, and it is notable that however much the spread of mountain bikes has been helped along by developments in manufacturing techniques, by the organisation of production and by changing global economic relations among producers, the key to the success of mountain bikes has been their cultural resonance at several levels.

During the mountain bike booms in the U.S. and UK, these novel machines, whose design was based on post-war children's bikes, evoked memories of childhood cycling among the baby boomer generation. This evocative nostalgia was an important aspect of the rise of mountain bikes as a cultural product, not just in the United States – as might be expected – but in Britain also.<sup>59</sup> It ensured that unlike the BMX boom that had come a few years earlier, mountain bikes were identified from the start as adult bikes, and not, initially, as children's bikes at all. Mountain

bikes in their early days carried clear connotations of the yuppie consumerism of the 1980s, something that manufacturers such as Muddy Fox capitalised on from the start.<sup>60</sup>

Their cultural resonance for baby boomers also tied them into some of the boomers' key cultural concerns at this time – health, fitness and the environment. At a time when utility cycling had seriously declined – or even disappeared in many cities in the U.S. – mountain biking revived adult leisure cycling as a route to improved health, and also as an activity that allowed people to engage with the countryside – something that refers back to the point made earlier in relation to cyclists' ambivalent relationship to modernity. This ambivalence resulted in mountain bikes becoming simultaneously associated with a growing concern for the environment, yet at the same time being seen by certain groups as a threat to it. As growing numbers of mountain bikers took to the American wilderness, environmentalists became concerned at the threat posed to natural habitats and forest ecosystems. This led to restrictions being imposed on mountain bikers on the very tracks where the sport originated. In the UK, smaller numbers of mountain bikers, and a more managed countryside landscape, have meant that there are mostly voluntary agreements in place in the national parks that are affected.

Despite environmental conflict over the use of mountain bikes in the wilderness, in urban areas the technology associated with mountain bikes has been important in boosting the role of cycling more generally as a component of growing environmental awareness, especially in relation to traffic problems such as pollution, congestion and the depletion of resources. Alongside their evocative qualities, various technical features of mountain bikes have enhanced their attractiveness to adult users, making them central to a growth in cycle sales and use. Their sturdiness and resilience have made them seem ideal for negotiating poorly maintained city streets and leisure tracks such as canal towpaths. Their upright riding position, and the rapid innovations that have appeared through the 1980s and 1990s to improve braking and gearing, mean that they are seen as ideal bikes for inexperienced riders or those who simply feel unsafe in traffic on a racing bike. There are concerns about the ecological impact of mountain bikes, especially the built-in obsolescence of many components, and their inaccessibility for amateur repairs. Nevertheless, in an urban context – and more so in Britain than the U.S. – rather than damaging the environment, mountain bikes have come paradoxically to be seen as one route to protecting it, by encouraging more people to abandon their cars for cycling.

The above discussion indicates how mountain bikes have come to be ubiquitous in a range of contexts that are often far removed from the downhill mountainbiker racing where they originated. To an extent, they represent a global cultural spread of the values of American baby boomers; nevertheless, it is possible to see differences in how these values are re-contextualised locally just by looking, as I have, at

the British and American contexts. Research into other markets outside the West, or even the northern European settings where cycling never shifted so fully from a means of transport to a leisure activity, would provide further insights into the re-localisation of this globally flexible technology.

### Conclusion – Beyond Globalisation in the Sociotechnical Frame of the Bicycle

In this article I have described two processes of change from a British perspective. The first of these processes, involving a shift from an early, craft-based sociotechnical frame to one rooted in mass production and consumption, was instrumental in establishing Britain as the dominant global supplier of bicycles, with markets and subsidiaries throughout the developed and developing worlds. Bicycle design was standardised across this global market, based on a conception of the bicycle as a sturdy, reliable and easily maintained transporter of people and – often – goods. This was matched by a home bicycle market that was rooted in utility cycling, alongside a further dimension of cycling culture, the escape from modernity that was expressed by leisure cycling in the countryside.

The subsequent disintegration of this sociotechnical frame brought about transformations that mean that the global relations of cycle production have been thoroughly destabilised and reconstituted. Distribution is no longer primarily unidirectional, as was the case when mass produced bikes were exported *en masse* from Britain to markets in its former colonies. Instead, production is fragmented across the globe, involving complex and multiple exchanges among different production centres. Distribution is also fragmented, in ways which blow apart the industry's earlier colonial relationships – in some cases, former colonies now export to Britain; in others it is hard to even state categorically whether a bicycle should be regarded as British (where it was badged) or far Eastern (where it was designed and manufactured). Matching these changes in production and distribution is a fragmentation of cycling markets and of cycling culture. Markets in the developing world can no longer be relied on to import huge quantities of Western goods; whilst in the home markets of companies such as Raleigh, consumers will no longer support mass producing and standardising industries, preferring instead the variety of choices offered by flexible specialisation. This shift in consumer tastes (which has both helped bring about, and been shaped by, industrial change) reflects a diversification within Western cycling cultures to include a variety of different kinds of cycling (mostly leisure-based) requiring different kinds of products.

The resultant changes in both British production and the commodity chain that supplies British consumption mean that it is no longer possible to speak with any certainty of a British bicycle industry. Although there are British manufacturers of

bicycles, bicycle components and accessories, these are all tied into a variety of global networks of relationships of manufacturers, suppliers, sub-contractors and consumers, that can best be understood in terms of the *global commodity chains* discussed earlier. It is noteworthy that the two sociotechnical frames of the mass and the globally flexible bicycle equate more-or-less to the two kinds of commodity seas markets that characterised the British cycle industry until the 1960s have been superseded by the more dynamic approach of newer entrants to the industry, and even the few remnants of the old approach have had to change their practices. This is evident in the way Raleigh's parent company during the late 1980s and 1990s, Derby International, also owned a trading company in Taiwan, which could source and supply parts for bikes to be assembled in Nottingham. This situation is aptly described in Ceterfi's account of *triangle manufacturing*, where firms in the Newly-Industrialised Countries of the Pacific Rim act as trading company sub-contractors for Western manufacturers; for Ceterfi, this an important factor in facilitating successive shifts to cheaper labour markets.<sup>51</sup>

Ceterfi raises an important question concerning who benefits from such developments. He argues that the sub-contracted nations involved in triangle manufacturing can only benefit if they can somehow acquire the most value-added position within the commodity chain – as happened with TI Cycles of India's purchase of Muddy Fox. It is, for Ceterfi, always the core firms in the chain who have most to gain. This is undoubtedly true, although the complexity of global commodity chains sometimes makes it difficult to identify quite where the core is. For the bicycle industry, certainly, it isn't entirely clear whether the core is the American and British branded mountain bike companies, or the Taiwanese trading companies and factories whose economies of scale have enabled them to take a market share that would have been incomprehensible as recently as fifteen years ago. It is similarly difficult to state categorically whether the shift from a strong global position to a weaker one has necessarily been a bad thing for British manufacturers, given the unsustainable direction the industry was moving in during the 1980s – for example, Raleigh's unquestioning sense of prosperity allowed it to open a new factory in 1957 at a cost of £3 million, which it then had to leave empty for five years as sales began to go into decline for more-or-less the first time in the company's history.

One shortcoming of an approach such as Ceterfi's is that like much other discussion of globalisation – particularly as the phrase enters popular discourse – it fails to maintain an understanding of the links between economic and cultural change. In both the sociotechnical frames of the bicycle that I have discussed at length, the economic and the cultural have been interdependent. In the shift towards global flexibilisation, especially, the outcome for the British cycle industry would have

been very different had it not coincided with the emergence of mountain bike culture; similarly, mountain bike culture would probably have suffered a similar fate to BMX had the industry not been so receptive to a new, and highly marketable, product innovation to accompany its new production and organisational innovations.

That said, it is important to note that the ways in which the production and consumption of bicycles have changed with global flexibilisation are not identical. Whilst changes in production and organisation make this industry something of an exemplar of globalisation, the consumption side is very different. There has been without doubt a global spread of the products of this new sociotechnical frame, but this has not been even across all markets. Rather, there has been an intensified differentiation between developed and developing world cycle markets. The mountain bikes which typify global flexibilisation have come to dominate cycle sales across much of the developed world, despite their very strong and specific cultural resonance primarily for American baby boomers. Their meaning and utility have somehow been translated and relocalised into very different contexts than the Californian mountains where they originated, in part through the multiplicity of design variations that new production methods have made possible.

In contrast, cyclists in the developing world – often in the very countries where many mountain bike parts are produced – still ride, for the most part, standard heavy roadsters which are very similar to those that Raleigh was exporting around the globe in the 1950s. The globalisation of production does not, then, represent a thorough globalisation of cycling culture, which has instead divided into two distinct cultures – one maintaining traditional uses and values for the bicycle as a mode of transport (albeit encroached upon by the gradual emergence in the developing world of a car culture); the other increasingly fragmented among different uses, primarily centred around leisure and sport. The crucial point to note is that the bicycle industry which has been globalised is the one which is geared towards the latter markets, matching the continual desire of consumers for innovation and change with its own continual search for cheaper labour costs and the least regulated production conditions. Indigenous cycle industries in Africa and Asia have not experienced anything like this amount of change. Seen in this way, globalisation does not appear to represent something that is strikingly new in the history of capitalism.<sup>42</sup>

What does the future hold for the bicycle, and what might be the characteristics of its next sociotechnical frame? There are many possibilities, and exploring these opens up questions not just about the future of technology and society, and about the relationship between transport and leisure, but also about the role of analysts of sociotechnical change in lobbying for and even trying to bring about certain kinds of sociotechnical scenarios. Is it enough simply to tell the story of a technology such as the bicycle, or should we be actively engaging in debates about technology,

change and globalisation – debates which have become public and highly political in recent years, for example in the way that the work of Anthony Giddens<sup>43</sup> has influenced the British Labour Party, and in the conflicts over who controls world trade that have been evident in the international protests against the World Trade Organisation, the G8 and so on?

There is considerable scope to explore in far more depth the issue raised by Gieroff of net winners and losers in the development of global commodity chains. In the bicycle industry, there are implications both locally and globally arising from the shift from a monolithic British-dominated world cycle trade to one where British companies are just part of a larger chain. This raises important questions over the precise ways in which the sociotechnical frame of the bicycle might develop beyond globalised flexibility. In terms of production, the mass British manufacturers of the 1950s and 1960s might well be simply replaced by others – notably the Taiwanese trading companies and the component giant Shimano – whose activities are just as imposing as those of their predecessors for peripheral participants in the commodity chain. For this reason, many cycle activists and even some industrial players mobilise to resist the power of a company such as Shimano.<sup>44</sup>

In the context of consumption, it is to be hoped that the bicycle will become a more integral component of a sustainable transport system, and thus move beyond its primary position at present in the UK as a leisure object whose use is often dependent on unsustainable transportation, such as when people drive their mountain bikes out of the city in order to then ride in the countryside. Such a shift is, I believe, to be strongly encouraged, and gains support from UK policy shifts which favour the development of sustainable transport networks. The bicycle is, hopefully, only at the modest beginning now of a renaissance as a mode of transport rather than as a leisure object.<sup>45</sup> This could have substantial benefits for the bicycle industry, too, especially at the relatively underdeveloped utility end of the market – provided the industry shifts its focus to match policies which are already some way advanced, on paper at least. Perhaps British cycle producers and consumers have something to learn here from the former colonial markets where cycle production and repair remain indigenous industries that support a transport-based bicycle culture.<sup>46</sup>

How important utility cycling, and an industry geared to supporting the utility market, will come to be as components of the next sociotechnical frame of the bicycle, remains to be seen. Highlighting this possible path for the sociotechnology of the bicycle shows, at the very least, the importance of addressing the social and cultural as well as the technical components of sociotechnical change. In order to increase utility cycling it is necessary to pay attention not just to the technical infrastructure of cycleways which is the most common approach of cycle campaigners, but also other factors such as: the social and cultural infrastructures of cycling, for

example the constraints and opportunities for cycling afforded by people's domestic and workplace situations; bicycle accessories; the design, production, marketing and distribution of bicycles; and the global organisation of the bicycle industry. The notion of *sociotechnical frames* is a valuable tool in helping us to understand change in this way, as heterogeneous. To return to my earlier comments on Bijker's work, sociotechnical change, in his analysis, comes across as a characteristic of particular artifacts and the groups whose interactions and activities within a technological frame constitute those artifacts. What I have tried to present here is an approach that shifts the focus slightly, so that change is instead a characteristic of a process that may centre on a particular artifact or group of artifacts, but involves also a whole range of disparate elements including the relations of production, national and global economies, and the cultural meanings of these products and processes. Sociotechnical change cannot be reduced to any one of these elements, but rather is a product of their inter-relationship.

## Notes

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