

PUUNK my ride: development of the Personalised User-generated Upcycled N-configurable Kit velomobile.

Mark Richardson¹, Karen Burns², Brad Haylock¹

¹Monash University, Department of Design

²Monash University, Department of Architecture

Email for correspondence: Mark.richardson@artdes.monash.edu.au

Abstract

Cycling is a highly efficient form of low carbon transport, but to date, cyclists have had only marginal representation on Australia's roads. There are various reasons for this, such as cyclist safety, product quality, weather, road conditions, and social drivers. The velomobile, however, presents an alternative to the standard two-wheel bicycle that would overcome many of these issues and thus offers a way to travel short and medium-length distances with zero emissions. This paper argues that, while velomobiles are a comfortable commuter cycling alternative, their current lack of widespread usage is due to negative socio-cultural perceptions of this type of transportation and the lack of a diverse range of 'Cool' velomobile products. It discusses the relevance of creative activist intervention as a means of developing products beyond the limits of their original design and of firmly embedding these products into social practice. It cites the Punk movement of the 1970s and its influence on current 'DIY' (do-it-yourself) 'mashup' culture; where web 2.0 enabled, open-source, user-generated product development is redefining whole systems of design, manufacture and retail. The paper goes on to outline the development of the PUUNK (Personalised, User-generated, Upcycled, N-configurable Kit) system as a framework for an open-source, reconfigurable, low cost velomobile.

1. Introduction

1.1 Cycling in the city

In an urban environment, cycling can be a good alternative to driving a motor vehicle. Being one of the most energy efficient, low carbon, minimal spatial footprint forms of transportation, the bicycle can often provide relative trip-time parity with cars in urban areas, given their ability to be taken on public transport, negotiate routes inaccessible to most forms of motorised transport, and to be stowed 'right on the doorstep' of the final location. Bicycles are also cheap, easy to maintain, and there are obvious health benefits associated with the physical nature of riding. However, here in Australia bicycles are unlikely to replace cars in the same way as they have in countries like Denmark and The Netherlands. This is due to a number of contributing factors that determine a commuter's willingness to ride. The factors include: the limiting psychology of a systemic motor car culture, the characteristics of the chosen route (hilliness, obstacles, traffic conditions and road surface), weather variability, the quality of facilities for cyclists at the journey's end, the quality of the bicycle and the tyres used, the age and health of the rider, and regulations requiring cyclists to wear a helmet

(Parkin 2007; Clarke 2008). Velomobiles – fully faired¹ human powered vehicles (HPV) – have the capability of overcoming some of these issues: they offer weather protection, aerodynamic qualities, some crash resistance, and built-in stowage space that may coerce potential riders to take up cycling (Van De Walle 2004; Cox 2004). Given these attributes velomobiles should be experiencing a growing market base, yet to date they have seen little uptake as a commuter alternative.

1.2 The velomobile as a commuter vehicle

Velomobiles can provide many advantages for commuters over regular safety bicycles.² They deliver greater speed and efficiency – primarily due to the drag reducing aerodynamic qualities of the outer fairing (Kyle 1974; Fuchs 1998) – meaning greater distances can be travelled over a shorter period of time with equal or less energy expenditure. Their ergonomic layout also usually places the rider in a reclined position, offering the ability to manage internal comfort and to relax when the vehicle is stationary. This position reduces neck strain, improves visibility (given the position offers free movement of the head), reduces crotch pain and injuries, gives the rider a support to push against while pedalling, and reduces strain on lower back and wrists (Martin 1984; Kita 1997; Wilson et al. 1984, as cited by Reiser and Peterson 1998). Velomobiles are lightweight and have a small spatial footprint relative to cars, which means that they can be stowed indoors and easily parked at a destination, similar to motorbikes, bicycles, mopeds and motorized mobility scooters. They provide relative safety when compared to bicycles – the rider is positioned feet first, as opposed to head first, with the shell offering some energy absorption and scrape protection. They are versatile, agile and, in most cases, fall under bicycle regulations which allows them to be used on both roads and bike paths. The health benefits of human powered mobility are also obvious, given pedaling to a destination provides exercise for the rider, while utilizing cheap, renewable, clean energy (Van De Walle 2004: 61-67).

Velomobiles, however, are not without their shortcomings. First, they are more complicated and unwieldy than bicycles, and despite having a smaller spatial footprint than a car, they are more difficult to store than a bicycle. Second, given their small scale niche production, availability is limited and costs are comparatively high (Cox 2004). Third, the surface area of the outer fairing, while offering reduced frontal drag, is susceptible to cross winds, which reduces vehicle handling (Fuchs 1998; Rasmussen 2009). Fourth, safety is an issue when considered in the road-vehicle mix, despite assertions that good visibility for the rider improves the safety for the rider (Van De Walle 2004; Reiser and Peterson 1998). The typical low ride height of velomobiles places the rider low in traffic. Given their vastly smaller spatial footprint, this has significant visibility implications for other road users when a velomobile sits amongst much larger vehicles. A safety flag is often attached to a pole on the back of the bike to make it more visible; however, this only marginally improves the visible mass of the rider and vehicle. Fifth, cyclists are often discriminated against in traffic. Many roads do not currently have cycling lanes, meaning that riders are limited in the number of safe routes available. Additionally, personal experience shows that, in a mix with larger vehicles, a more vulnerable cyclist can often be forced to concede to larger vehicles – sometimes regardless of holding right of way. This is little wonder given there has been a lack of government funding in improving cycling technology, road infrastructure and education when compared to automobiles (Van De Walle 2004). Despite these shortcomings, however, it could be argued that the potential benefits of velomobiles outweigh the disadvantages; so why are velomobiles not a more common mode of transportation on our roads?

¹ An outer shell that protects the rider and provides aerodynamic benefits.

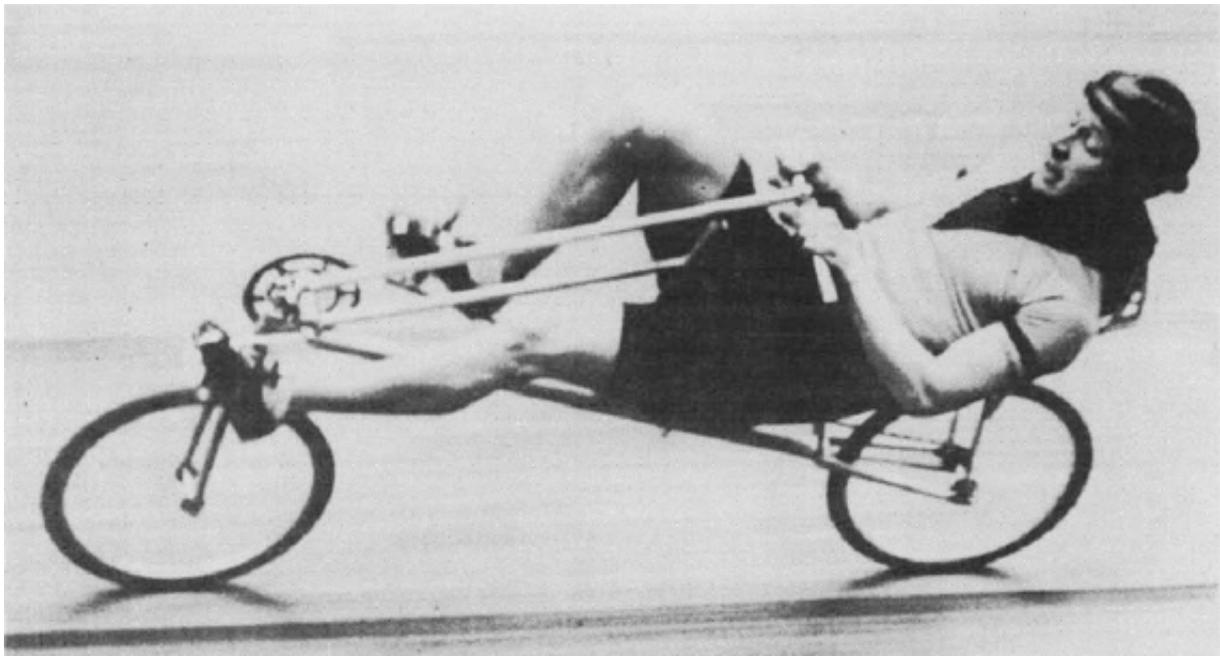
² Bicycles with a standard triangulated frame.

2. Technology, art and the socio-cultural perception of the velomobile

2.1 Practicality vs. perception of the velomobile

It is argued here that the minimal presence of velomobiles on our roads is less likely to be due to the pragmatic issues of day-to-day use than that of socio-cultural perception, lifestyle and image. Bijker (1995: 6) states that ‘...one should never take the meaning of a technical artefact or technological system as residing in the technology itself. Instead, one must study how technologies are shaped and acquire their meanings in the heterogeneity of social interactions’. The velomobile and its cousin, the recumbent cycle, have long been socially marginalized, suffering from the perception that they dwell in the domain of cycling specialists, elitists and fringe activists. Koelle (2010) mockingly refers to recumbent riders as ‘The Contraption Captains’, who ‘mean no harm ... they’re simply operating machines they feel are superior to regular bicycles because they’re potentially faster and they don’t require a rider to sit on a narrow saddle’. Cox and Van De walle (2004) state that: ‘...when trying to understand how the velomobile relates to most people’s experience of the “bike”; the phrase “does not compute” comes to mind. Yet the design expertise, development and marketing of contemporary velomobiles in practice, has largely identified them as a specialist province within cultures of cycling.’ Van De Walle (2004:70) goes further to say that in an evoliner³ framework, the velomobile is the most marginalized form of cycle, in a world where the bicycle is already marginal to the automobile. The velomobile is, in effect, perceived as an orphaned hybrid, sitting somewhere between a cycle and a car, disowned by the cycling community and shunned by motorists alike.

Figure 1: Francis Faure breaking the world record in 1933 on Charles Mochet’s velocar design (Schmitz 1994)



Cycling sport has been attributed much of the blame for this marginalization of velomobiles, with the earliest and perhaps most damaging incident occurring in 1933-34. The Velocar – a recumbent bicycle designed by Charles Mochet (Figure 1) – broke the long-standing Hour Record in Paris after being granted permission by the International Cycling Union (UCI) to

³ The linear evolution of an associated group of artifacts, for example bicycle – motorbike – car.

participate alongside traditional bicycles. Ridden by Francis Faure, a second category track cyclist, the win sparked a controversy and questions were raised as to the legitimacy of the record, given the unorthodoxy of the bicycle compared to its competitors. The record was later revoked by the UCI and the recumbent bike was assigned to a separate 'specialty-bike' category. This act, given the perceived authority of the governing body, limited all official competition to those riding standard bikes. It could be argued that this exclusion of recumbent-style cycles from official competition limited motivation for the technical development of this style of bike and, in turn, restricted the formation of a legitimized culture of recumbent cycles (Schmitz 1994; Earnest 1995; Fehlau 2003:13-14; Cox 2006). Despite the existence of various forms of recumbent and velomobile racing,⁴ these rules continue to this day.

The success of the standard cycle is closely linked to the form and materiality of specialist sports cycles (Cox 2006). Recumbents and velomobiles are far from the familiar and desired norm of sport cycling, and, in spite of being recognized for their superior comfort, manufacturers have shied away from developing them for the retail market. Perhaps ironically, the closer a product represents the aspired-to sport bikes, the less likely they are to fulfill the comfort, luggage carrying capacity, weather protection, reliability and durability required of a daily commuter cycle (Cox 2006). Put simply, it appears the general perception of velomobiles, and to a lesser degree recumbents, is at odds with the benefits of what they can deliver. This creates a clear conflict for designers in the field, given it is difficult to provide appropriate commuter functionality while achieving a successful product image when the safety bike (appropriating the form of sports cycles) is seemingly the only desirable format. This demonstrates that merely 'working' with regards to function is not the only criteria for the velomobile to gain widespread popularity. Instead, the notion of an artefact 'working' is seamlessly embedded within a socio-cultural frame – it needs to 'work' in the continuum of a cultural narrative and provide emotive validation to the end users in as much as it needs to function in a technical sense (Bijker 1995: 15).

2.2 Velomobiles and the notion of 'Cool'

To illustrate the importance of social drivers in the development of an artefact, Bijker (1995) charts the development of the bicycle from its beginnings as a play thing for the social 'Dandies' in the late 18th century through to the safety bicycle we know today. He argues that it is the sum of the social interactions in the development of an artefact that is intrinsic in the development of the technology, resulting in a 'technological frame' – i.e. the stable and accepted form (appearance, structure, function) for a technology to take over time, established by a linear string of socially determined events. Van De Walle (2004) compares Bijker's notion of the 'technological frame' to Rosen's (2002) subsequent refinement of the theory – of the 'sociotechnical frame' – which argues that the notion of the 'technological frame' struggles to account for multiple artefacts being developed around a central theme by different social groups. Rosen's theory suggests that artefacts that have come to be deeply rooted in social custom may be developed in multiple forms and be interpreted in different ways by diverse social groups concurrently, but nonetheless be grouped under the same symbolic umbrella in a cultural terrain. When discussing the velomobile and its (lack of) broader social acceptance, Van De Walle (2004) expresses the need to consider it as separate to the sociotechnical frame of both the bicycle and car in order for it to enjoy greater market leverage.

In order to form a stand-alone sociotechnical frame, however, a number of well entrenched paradigms regarding the velomobile first need to be shifted. As mentioned, foremost are the perceptions that they are either (a) complicated and specialized cycles, or (b) lesser cars. Van De Walle (2004: 81) states: 'In the evoliner perspective, there is a big risk that a

⁴ See the RACV Energy Breakthrough, for example: <<http://www.racvenergybreakthrough.net>>.

velomobile (subconsciously) is evaluated as an expensive, heavy, complex, large and difficult to park... bicycle with extra wheel(s) and a body on top of it. The fallacy is obvious, it is like expecting an automobile to live up to motorcycle standards or calling an automobile a 'four-wheeled, streamlined, recumbent motorcycle.' Velomobiles need to be clearly differentiated from their predecessors by being designed to meet needs that cannot be met by either a car or a bicycle, while taking on a distinct and unique form. In effect, they need to be designed to convey cultural symbolic relevance, not just technical proficiency; a desirable blend of function, aesthetic and usability... But, will this make velomobiles 'Cool'?⁵

'Cool' is an elusive and arguable quality and can have make-or-break impact on designed products in the marketplace. Artefacts can be validated and more broadly accepted subsequent to their adoption by Cool subcultures. When one is outside an existing Cool ingroup, however, it is difficult to artificially construct artefacts that will appeal to that ingroup; what is Cool is highly contingent on the views of a collective of social activists playing their part on a constantly shifting political, environmental, economic and social stage. Pountain and Robins (2000: 142) argue that Cool is '... an oppositional attitude adopted by individuals or small groups to express defiance to authority – whether that of the parent, the teacher, the police, the boss or the prison warden. Put more succinctly, we see Cool as a permanent state of private rebellion'. Franklin (2007) also sees activism as a path to making Cool, terming the process 'Stylistic Arrhythmia' – where objects rejected by a cultural mainstream are appropriated by a subculture that wishes in return to reject the mainstream and create an identity forged from difference: this then sets up a dissonance that breaks the normal rhythms of that cultural mainstream.

Not every activist action, however, makes Cool. The countercultural movement of Velomobile riders – one that takes a stance rejecting dominant car culture, or that rejects the pace and features of standard bicycle culture, preferring to use human powered transport as a point of difference – is yet to prompt a broadly held view that the velomobile is a Cool artefact. As stated earlier, it seems more that these vehicles are seen as the idiosyncratic choice of a small group of enthusiasts. This dichotomy between eccentric and Cool would suggest that there are a number of other issues at play. In seeking a more widespread acceptance of velomobiles, it is important to consider what these issues are.

Cool is in the eye of the beholder; however, individual perception is contingent on the dominant views of relevant ingroups and the boundaries that define them. Symbols and behaviours mutually reinforce an individual's membership to an ingroup and differentiation from the outgroup. These act as a means for recognition of one's entitlement to receive benefits and feel a sense of belonging (Brewer 1999:433). The aesthetic symbols of the ingroup – products, fashion, activities, frequented locales, language and networks – are an expression of ideals and are encompassed by lifestyle and aesthetic style (see for example; Mehta & Belk 1991; Douglas & Irshwood 1979:4; Kleine, Kleine & Kernan 1993:229). Franklin (2010:125) states: 'Because lifestyle owes its origin to its counter cultural antecedents, the notion of cool is very central: which is why 'cool' has become generally synonymous with 'good' or good style.' The perception of style differs between social groups: what is cool to a velomobile rider, for instance, may not be cool to a Hipster⁶ – until either a cultural icon from the Hipster world adopts the vehicle as part of their 'uniform' and others follow by association;⁷ or a Hipster version of the product is developed that is aligned stylistically with their ideals and aesthetic language.⁸ Aesthetic style, as a demarcation of Cool ingroup membership, is ephemeral given it is often appropriated by outgroup individuals

⁵ 'Cool' meaning a 'calmly audacious' ('cool' 2011) act of rebellion, with a countercultural style.

⁶ See Lanham (2003) for definitions of Hipster culture

⁷ A comparison might be when Harley Davidson motorbikes ridden by members of the Hells Angels are appropriated by office-working weekend warriors for image sake.

⁸ The adaption of a regular track bike frame to become a swap-card spoked, brakeless, narrow handlebar, fixed wheeled Hipster mobile.

wanting to be identified with a Cool subculture for image's sake. Thus aesthetic image can prove critical in the ongoing process of ingroup demarcation.

The success of a product in relation to a particular ingroup depends on a timely mix of its cultural associations, social positioning, historical context, technological relevance, human-centred usability, functionality, economic justification and accessibility. These elements can be synthesized by aesthetic cues that embed an artefact within its given context (see, for example: Dewey 1934; Bourdieu 1987; Goldsmith 1983; Gotshalk 1954; Coates 2002). The role of the inventor, designer and artisan to make an artefact that provides the stylistic and emotive links necessary for it to be aesthetically and conceptually demarcated from a cultural mainstream is contingent upon understanding these parameters.

2.3 The role of designers, artisans and artists in the making of Cool

Many believe that design, in its purest form, is the successful integration of the rationality of technology and the emotiveness of art. Arnheim (1970) states that the interplay between technology and fine arts can allow freedom from known practices and engender a heightened connection to the emotive. Papanek (1972), perhaps one of the most recognized eco-design activists, considers design to be the conscious effort to impose meaningful order; and Krane (1972) elaborates on this notion of consciousness, or awareness, to imply that it is gained through the practical application of philosophy which he considers to originate in art. Pirsig (1998) goes further to say that objects that meaningfully synthesize technology and art embody greater depth, insight, and individuality, and in turn combat 'thin arts' (art with very little assimilation or extension into underlying form). It is the overlay of pure 'artfulness' that can successfully integrate an artifact's underlying functionality, embodied technology and capability to evoke delight when interacted with by the end user. Furthermore, it could be argued that Cool often results from the work of artists, artisans and designers – activists who are able to synthesize invention, structure, form, style, concept and ideal to make objects of desire. These objects, if created within a reflexive environment, can find a relevant and enduring place in the continuum of a contemporary social context.

2.4 The role of association: mimicking the behaviour of cultural and sporting heroes

The social relevance of these Cool objects is also reinforced by their association with cultural heroes (Pontain 2000:127). In a transportation context, for instance, car, motorbike and cycle culture have developed distinct, rich and varied countercultural/subcultural elements which have strong technological, sociological and political roots. The diversity of product availability – varying styles, models, makes and vintages – provides a rich ground for custom builders, modders, hot rodders and car tuners to make Cool products. The ever-present hotrod subculture, for instance, emulates the custom built vehicles in which perilous feats of speed were performed by the DIY-built dry lake racers at El Mirage and Boneville in the postwar 1940s and 1950s; the rebirth of the café racer scene in the early 2000s has taken on the persona of the 'devil-may-care' rocker movement from the early 1950s; the high performance race scene, represented by categories such as F1, Dakar Rally, GP Moto and drag racing provide an array of death-defying sporting heroes that are emulated by a variety of 'need-for-speed' ingroups; the allure and sophistication of the time trial fixed gear scene from the late 1800s and the dare-devil nature of the New York Bike messengers in the late 1980s and early 1990s set the scene for fixed gear (fixy) culture in the early 2000s;⁹ and the history, technology and feats of human endeavour of the heroes of the Tour de France is mimicked by lycra-clad road warriors. Many of the founding subcultures have been established by DIY artisans and inventors, and have subsequently been defined by their heroes, aspirational

⁹ This has, in turn, diffused down to the commercial level with aspiring 'Hipsters' able to purchase ready-made fixies without having to go to the trouble of modding their own bicycles.

leaders, 'rebels without a cause' and rock-star creatives with attitude to spare and an axe to grind.

2.5 Functional and aesthetic paradigms

Velomobiles lack critical mass in both diversity of form and relevant association with recognizable subcultural leaders and sporting heroes. They are also fighting the perceptions embedded by past failures. In recent history, for example, the overwhelming failure of the Sinclair C5 after its introduction to the UK market in 1985 was indicative of the broader community's perception of this style of three-wheeled, electric pedal-assist vehicles within the context of dominant car culture. Comparative to a motor vehicle, it appeared unsafe, toy-like and 'un-Cool'. It has been argued that the lack of market research undertaken by the Sinclair team in the process of product development was a major contributor to the C5's demise (Marks 1989). The product itself had many technical flaws, but probably the most damaging aspect was that it looked somewhat ridiculous when placed on the road next to other motor vehicles. The media coverage at the time reinforced this view, which in turn entrenched a socially adverse perception of these types of transportation.

Over recent decades, velomobiles have also been limited by a distinct aesthetic paradigm – an ingrained expectation of what a velomobile 'should' look like. They have been engineered with performance and aerodynamics as key features – usually using the underlying infrastructure of a recumbent cycle (but not always, as in the case of the monocoque Alleweder), and applying a sleek, porpoise shaped enclosure.¹⁰ It could be argued that these sleek forms struggle for wider audience appeal because they lack aesthetic and structural design diversification (Bunte 2009). However, this diversification could more easily be achieved and disseminated if there were a social and design-based mechanism to facilitate it.

3.0.0 Punk 2.0: A DIY ecology for product diversification

In 2004 Danger Mouse, a UK based musician, released the Grey Album – a collection of 'mashups' that cut, looped, overlaid and mixed passages from songs lifted from the Beatles *White Album* and acapella versions of Jay-Z hip-hop tracks from *The Black Album*. Danger Mouse released only a few thousand copies amongst friends and independent music retailers, suggesting that this was not a mercenary exercise but rather a statement of intent to undermine established industry regulations and pro formas. The album went viral via file-sharing sites, with over a million downloads; an achievement that would have put it at the top of the charts had it been released through regular channels (Gunderson 2004). It was created through the use of contemporary digital tools that make music composition and recording accessible to anyone who has a computer, and widely disseminated by anyone who has internet access. The music industry has been powerless to put a stop to the practice, given the inability to enforce copyright legislation in certain digital-mediated circumstances and the number of individuals willing to defy these laws, thus demonstrating the capacity of a DIY approach to reach a broad audience and change the way we approach the creation and distribution of 'product'.

The above example is also indicative of the gradual democratisation of technology which is, in turn, fostering what might be described as utopian impulses (Gunderson 2004). A burgeoning culture of DIY artisans, empowered by the rise of Web 2.0, social media and creative software tools, are able to make and disseminate product outside normal consumer channels. These tools have empowered the marginalized, reduced scales of industrial

¹⁰ See for example: Leitra <www.leitra.de>; Trisled <www.trisled.com.au/index.asp>; Aerorider <www.aerorider.nl>; Cab-Bike <www.info-cab-bike.de.tl>; Go-one <www.go-one.us>; Alleweder <www.alleweder.eu>; WAW <www.waw-bionx.blogspot.com>).

production and delivered a voice to those who would have previously found it difficult to find a voice, thereby threatening the megaliths of industry. This new digital culture leans heavily on connectivity, pastiche and reuse, 'borrowing' and manipulating the work of others and, in the case of the music scene, allows 'bedroom artists' to make a competent product without the need to be proficient with any musical instruments themselves.

From a product design perspective, the tools have extended to 3D low volume manufacturing. Laser and vinyl cutters, low cost CNC machines such as the Lumenlab MiCRO and open source machines such as the Rapman 3D printer have enabled a groundswell of designer-makers to develop products for low volume production. To facilitate this, build-instructions ('instructables') and model data can be easily disseminated via the internet. At present, it is a commonly held belief that the structural integrity of printed parts has been lacking, but with the development of Selective Laser Sintering (see Agarwala 1995) structural parts can now be produced with a method known as Additive Layer Manufacturing (ALM)¹¹. These parts can be made from plastics and metals alike and, in many cases the smaller scale of the machines allows production to be situated outside the traditional factory environment. Manufacturing processes no longer need to be operated by a crew of engineers, technicians and machinists utilising large, heavy machines; a single operator can produce complex parts from a room at home.

Centralized, hierarchical manufacturing and large scale production involve high investment and risk management. They involve separate phases of development that rarely involve the end user in the development process. The system relies on designers and product planners to understand the market base, and marketing specialists to gauge a product's applicability to it. Expensive and intense marketing campaigns are required to increase market acceptance through mass media exposure. If a product is too radical or challenging, the likelihood of it appealing to a broad market and recouping costs is diminished; consequently generalisation is often necessary. Traditionally, Industrial Designed artefacts are 'designed by few for many', which means that specific needs of individuals can only be met to a certain degree.

Open source, on the other hand, is closely related to the input of the end user, given it is they that are often involved in the making and testing of the product. The trend towards consumer-as-producer (Gunderson 2004) provides a framework for user-generated design, development and production – or 'design by many for many'. In short, 'since the publication of *The Practice of Everyday Life* [de Certeau 1984], companies have developed strategies that mimic people's tactics of bricolage, reassembly, and remix' (Manovich 2009). Products that are developed organically in an open source network can be modified, 'mashed-up' and evolved into many different forms to meet individual needs. It is a low risk strategy, given it involves a distributed cloud of DIY makers who need only commit to low investment costs. Additionally, market testing is actually part of the development of the artefact and if the original idea has market appeal it will generate its own viral dissemination.

Open Source development takes the notion of DIY production to a new level. User-generated products are designed from the outset with the explicit intention of being manipulated. The 'source code' is available for anyone to change, and when updated can be uploaded to join other user-generated content. The process of crowd-sourced development allows a product to evolve quickly and with relevance to a broad social group, given it is a product 'designed by many for many'. The potential of open source creativity is heightened by greater inter-disciplinary interaction; given creative design 'genius' rarely exists in isolation, a product of exposed to a network of multidisciplinary experts, thinkers, and creative individuals is more likely to flourish (Csikszentmihalyi 1997). Ideas gestate and grow as new information from outside sources is assimilated into the rationalization of a product.

¹¹ See EADS 'Airbike' <www.eads.com/eads/germany/de/news/press.8d764849-d439-475b-93b3-3cc9a7d2ba20.3d7b1259-b415-4264-ab4a-df571a8a9cc2.html?queryStr=airbike&pid=1>

The roots of DIY culture have been said to have come from the Punk movement in the 1970s. With the slogan 'Here's one chord, here's two more, now form your own band', the freedom for amateurs to become agents of change became possible (Hebdige 2002, as cited by Mason 2008). Open source design provides the 'three chords' from which individuals can make and adapt their own products, which implies the need for an inherent simplicity and modularity to the underlying system of product design and production. With a wealth of information available online, anyone can easily find out how to 'give most things a try' (Mason 2008). Mason (2008) argues that the lesser the constraint of previous knowledge, the greater the ability to innovate outside given paradigms. He states that the future belongs to a new breed of 'change agents' - the punk capitalist; a subculture with the philosophy that puts purpose next to profit. These are activists with an egalitarian mission, where making money, while it would not be turned down, is not the primary focus. It is difficult for current industrialized processes to compete with this new way of operating, and marks the shift from profit-generating, hierarchically controlled industries to more diversified, grass roots, digitally enabled, DIY, user-generated, distributed networks. This is Punk 2.0.

4.0 PUUNK production: velomobile design meets Punk 2.0

Automotive design in recent decades has tended to operate first and foremost with a styling agenda, relying heavily on engineering precedents to provide the skeleton over which they flesh out an aesthetic form.¹² In the process, the design of a vehicle is highly protected by confidentiality agreements and tight security measures, and a lead time of up to five years from conception to public release is often required. Designers are the ones that determine the stylistic evolution of a product in a hierarchical system of product development. In contrast, DIY design and production collapses hierarchical structures and provides a means for user-generated input to be intrinsic to the evolution of the design over time. It continues in the spirit of Punk – accessible to anyone who has access to some basic materials and tools and a desire to make their own low-cost product. Open source DIY design and production can speak the language of a new generation of Web 2.0 users who understand the notion of 'mashup' and enjoy the process of contributing individually to a broader culture of DIY activism.

4.1 'Here's some materials, here's some tools and a modular system, now make your own transport'

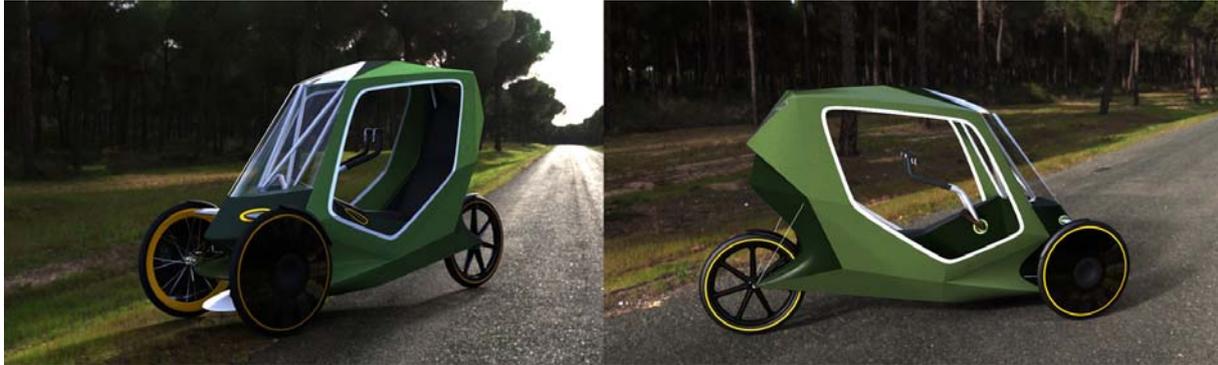
The PUUNK (Personalised, User-generated, Upcycled, N-configurable Kit) production system is intended to provide a means for user-generated product diversification and evolution. From a Design perspective, products designed for open production processes need to be accessible and easily modifiable. To this end, the PUUNK production process considers the product as a system of modules within an adaptable architecture. Participatory end-user interaction is intrinsic to the diversification of the end product, so the materials and construction tools need to be easy to access, the modules straightforward to assemble and the potential for adaptability high.

Within this system, the project design outcome is a low cost, electric-pedal assisted velomobile, within an open source, digitally mediated framework¹³ that can be easily accessed, interminably reconfigured, and made from found materials while using generic household tools for its manufacture (Figure 2). The design also aims to adapt to individual needs, commute comfortably to a distance of up to 20km, carry a small amount of cargo and eliminate the need to wear a helmet (Richardson, Vittouris & Rose 2010).

¹² These observations have been garnered during ten years of working in automotive design.

¹³ i.e. Using digital tools, such as CAD and visualisation software, to make virtual models and build instructions that can be accessed online. Information, developments and user/builder experiences can be exchanged through social networking sites and forums.

Figure 2: PUUNK velomobile



5.0 PUUNK velomobile structure

5.1 The Tensegrity Overlay

The construction of the PUUNK velomobile relies heavily on tensegrity structures – or tensional integrity structures (see, Krausse & Lichtenstein 2001:229) – as a means to make a strong, lightweight frame without the need for complicated tools or a high level of skill; as long as detailed build instructions are made available. Tensegrity structures use compression masts within comprehensive triangulated, three-dimensional tensional networks. The compression elements (usually a length of tube) and the tensional elements (usually high tensile wire) are held in a state of equal tension and compression (Buckminster Fuller 1961). The use of lightweight materials is an essential requisite in the quest for energy efficiency, as ‘...it [lightness] accommodates drastic reduction in fuel consumption in existing processes. This in turn brings within view the use of renewable energy in processes in which this has hitherto not been possible’ (Beukers, 2001). Building lightweight structures has far-reaching ramifications. Every process undertaken throughout an object’s development and construction has the potential to bear energy savings, from the manufacturing and freight of individual components through to final assembly and end use.

Buckminster Fuller’s aim was to achieve ‘ephemeralization’ – the evolution of complex systems towards ever lighter, more efficient and more invisible forms (Mollinari 2005:20). His design philosophy was also embedded in mass production and standardization, and mirrored Fowler’s edict to ‘enable the poor but ingenious man to erect a comfortable dwelling at a trifling cost, and almost without the aid or cost, as now, of mechanics’ (Fowler 1954, as cited by Mollinari 2005: 23). Buckminster Fuller’s appropriation of Kenneth Snelson’s tensional integrity structures, (which was later to become known as ‘tensegrity’), enabled Fuller to develop highly stable, lightweight constructions from a palette of highly accessible materials using a simple, versatile construction process.

The advantages of using a tensegrity system to build a velomobile frame are:

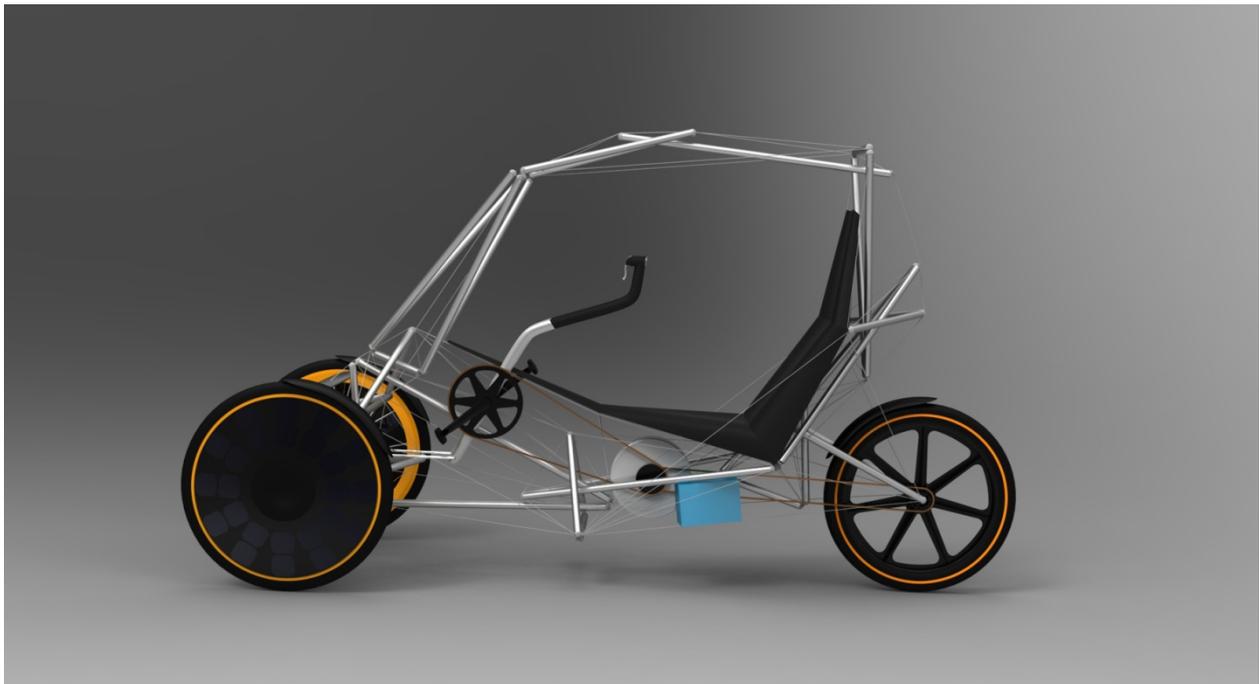
- It produces a strong, lightweight construction;
- The construction is modular and adaptable;
- The materials are easy to source and suit upcycling processes (outlined below);
- The frame is easily deconstructed for component reuse;
- It allows the connection of incongruent, unmatched gauges and sizes of materials;

PUUNK my ride: development of the Personalised User-generated Upcycled N-configurable Kit velomobile.

- The frame is a simple construction that can be assembled with a minimum number of tools – construction does not require a specialty workshop;
- The underlying simplicity makes it easy to establish open source contribution.

This research has explored a number of tensegrity geometries in the development of the velomobile frame. While the frame prototype pictured here (Figure 3) cannot strictly be termed a tensegrity structure – given the tensional network does not entirely define the outer boundary of the structure (Motro 2003: 27) – it is indicative of the direction the project is taking. Further design work has been undertaken since the pictured prototype to develop the frame as a true tensegrity system; however the later prototype was still under construction at the time of writing.

Figure 3: PUUNK velomobile frame prototype.



5.2 How PUUNK production methods apply to a diversified ecology of velomobiles

5.2.1 Personalisation

Product personalisation is intrinsic to the intent of the project. Given the system comprises two basic elements – the tensegrity frame and sewn fabric skin – diversification of the shape can be achieved by simply lengthening and shortening poles and wires on the frame, and patterns for the skin updated. In this way, the components and modules can be interminably reconfigured to make a form that suits the end users needs and aesthetic tastes. The materials selected for the skin and the way they are assembly is highly dependent on what the maker can find and how it is sorted, positioned, cut, sewn and stretched.

5.2.2 User-generated

The culture of Punk 2.0 DIY manufacturing relies on simplicity, accessibility and do-ability. The modularity of the system underpinning this project and the simplicity of the components and tools involved – a drill, wire cutters, pliers, hand swage tool, hack saw, metal file, scissors and sewing machine – allow continuing user-generated development of the design in an open source framework. Open source development conflates traditional production processes – the separate processes performed by designers, engineers, financial advisors,

manufacturing specialists and marketing experts – to be performed by the end user. Given the user is involved in the entire process, they are able to generate new content that relates directly to their own needs.

5.2.3 Upcycled

The simplicity of materials and construction for the PUUNK-style velomobile allows upcycled materials to be used, keeping investment costs low. Upcycling is a way of adding value to 'waste'. In some cases recycling processes can achieve these aims; however, energy and water savings can be made by avoiding reprocessing materials to a virgin state. In many cases, recycling also results in a downgrading of the material's constitution (Pilz cited in Thornton 1994; McDonough & Braungart 2002). The primary aim of upcycling is to refashion and integrate discarded components and materials into a new range of diverse products within open-loop cycles. For example, the LCD touch screen from a superseded mobile phone made by manufacturer 'A' could be repurposed to become a climate control touch screen in a motor vehicle instrument panel made by manufacturer 'B', then reused as the backlit LCD panel in a data projector made by manufacturer 'C'. The other components of the phone could equally be repurposed in a diverse range of alternative products rather than being recycled. To this end, the value of the material and components maintain equal or greater value as they have in the original artifact. However, each of these functions would need to be considered 'upstream' in the design stage of the mobile phone's production in order to fully cater for 'downstream' repurposing (Richardson 2011).

5.2.4 N-configurable:

The underlying premise of the PUUNK velomobile concept is the consideration of an individual product as an assemblage of functional modular components with multiple life spans, rather than a complete, stand alone object with a singular finite existence. These modular components can potentially be deconstructed, reconstructed and re-skinned in many different ways, turning the focus away from 'product longevity' to 'component longevity' (Richardson 2007). Once the vehicle is made, the PUUNK construction system allows it to be easily modified to suit the end user's needs. A single seater vehicle, for instance, can be reconfigured to carry an extra passenger or increase load space with the addition of further tensegrity modules or a modification of the existing components.

5.2.5 Kit:

The simplicity of materials and limited number of tools required allow the design to be easily packaged as a DIY kit of parts. Free build instructions,¹⁴ drawings, digital models and photographs will be available for download, with the intention that the end user can collect their own materials and tools to make the product. However, the kit has the potential to come pre-packaged or as a complete preassembled unit. This follows the precedent of projects such as the Reprap rapid prototyping machine (Reprap 2010) – a 3D printer made from easily accessible parts that can replicate many of its own parts to make another machine – and the Lumenlab DIY Projector (Lumenlab 2008) – a digital projector that can be made from LCD screens and various other parts that are easily sourced in most countries around the world (Richardson et al. 2010).

The downfall of tensegrity structures to date has been the exacting nature of assembly and the potential for a structure to fail if one of the elements fails. To counter these problems the design of the PUUNK velomobile provides a way for the structure to be made in a less exacting way and the component configuration has been designed with fail-safes in mind (this will be discussed in further detail in following publications). It is hoped that, with

¹⁴ Otherwise known as an 'instructable'; a complete set of instructions for making DIY projects that can be sourced from websites such as <www.instructables.com>. These are typically open source, encouraging new developments of existing projects to be documented and uploaded to the site.

subsequent open source contributions, these issues will be further alleviated to make a safe, comfortable and proficient product.

6.0.0 Conclusion

Cycling is a good alternative to motorcar travel in urban environments; it is a cheap, lightweight, energy efficient and healthy way to travel. However, there are many issues preventing the uptake of cycling as a widespread commuter mode in Australian cities – these include weather variability, landscape, traffic, road conditions and bicycle quality. Velomobiles, especially those with electric pedal-assist technology, overcome many of these issues; they are fully enclosed, comfortable, crash resistant, and aerodynamic. However, these vehicles have their shortcomings, not least of which is a negative perception by the broader community that they are either a complicated bike or a lesser car; a view which has been proliferated by cycling regulators, manufacturers and critics alike. Some believe that velomobiles need to be considered outside of the evoliner sociotechnical frames of the bicycle, motorbike and car in order to be more broadly accepted and utilised, but at present there is little indication as to how this could be achieved.

It is argued here that velomobiles need to be made culturally 'Cool', but in order to do this, it is necessary to provide a mechanism for product diversification. This mechanism needs to allow these vehicles to be aesthetically and functionally adapted by a variety of countercultural 'ingroups' to make their own appropriation of the product. For this to occur, it is important to include a wide group of inventors, artisans, artists and DIY designers in the development process. These individuals can synthesise socio-cultural trends and symbols into relevant forms, and encourage a new collective of cultural and sporting heroes to carry the image of velomobile Cool.

Tapping into the emerging trend of DIY consumer-generated products, it is possible to achieve these ends. Influenced by trends in music, the movement relies on the notion of the 'mashup' – the process of taking the work of others and mixing and overlaying product components to create new products in their own right. The rise of Web 2.0 has engendered a new breed of socially interactive tools and pro formas that allow individuals to make and disseminate information outside the framework of hierarchical production. This has sparked what Mason (2008) has termed 'punk capitalism' – or Punk 2.0 – where product creators are no longer invested in profit making as a primary goal. As part of this, open source design has emerged as a new form of social egalitarianism, culminating in digitally mediated, DIY production.

This project occupies the punk capitalist realm. A velomobile has been designed to be an open source vehicle to be manufactured in a method coined 'PUUNK' (Personalised, User-generated, Upcycled, N-configurable Kit) production. The design uses Snelson and Buckminster Fuller's notion of tensegrity as a means to make a lightweight, modular vehicle for everyday use. This system allows user-generated adaptability to govern product diversity with simple components easily sourced around the globe, and a modular assembly that provides a means for continual adaptability.

References

- Agarwala, M., Bourell, D., Beaman, J., Marcus, H., Barlow, J. (1995) "Direct selective laser sintering of metals", *Rapid Prototyping Journal*, Vol. 1 Iss: 1, pp.26 – 36
- Arnheim, R. (1970) *Visual thinking*, Faber, London
- Beukers, A. V. H., E. (2001) *Lightness - The inevitable renaissance of minimum energy structures*, 010 publishers, Rotterdam.

- Bijker, W. (1995) *Of Bicycles, Bakelites and Bulbs: Toward a Theory of Sociotechnical Change*, Cambridge, MA: MIT Press.
- Bourdieu, P. (1987) *The Historical Genesis of a Pure Aesthetic*, *The Journal of Aesthetics and Art Criticism* Vol. 46, Analytic Aesthetics, pp. 201-210, Published by: Blackwell Publishing on behalf of The American Society for Aesthetics, Article Stable URL: <http://www.jstor.org/stable/431276>
- Brewer, M. (1999) *The Psychology of Prejudice: Ingroup Love or Outgroup Hate?*, *Journal of Social Issues*, Vol. 55, No. 3, 1999, pp. 429–444
- Bunte, H. (2009) *Velomobiles and their Diversification: An Approach towards Greater Acceptance in Societies?*, 6th European Seminar on Velomobile Design, Copenhagen, October 2009
- Certeau, Michel de. (1984) *The practice of everyday life*, University of California Press, Los Angeles
- Clarke, C., 2008, 'Mandatory' can have unanticipated consequences: Assessment of Australia's Bicycle Helmet Laws, Civil Liberties Australia, <<http://www.cla.asn.au/0805/index.php/articles/2008/mandatory-can-have-unanticipated-consequ>>, Viewed 1 September 2010
- Coates, D. (2002) *Watches Tell More Than Time: Product Design, Information, and the Quest for Elegance*, McGraw-Hill, New York
- "Cool", Dictionary.com, Collins English Dictionary - Complete & Unabridged 10th Edition. HarperCollins Publishers, <<http://dictionary.reference.com/browse/cool>>, accessed: June 05, 2011
- Cox, P. (2004) 'Framing Consumption: Social Impediments to Velomobile Adoption' in Fuchs, Joachim (ed.) *Proceedings of the 5th European Velomobile Seminar: Towards Commercial Velomobiles*, Troisdorf, Germany: Deutsches Strassenmuseum, Germersheim
- Cox, P. (2006) *Stifling Innovation in Cycle Technology in Towards prosperity: Conference Proceedings, VeloMondial 2006, Cape Town (CD-ROM & Web Publication also as Podcast and excerpted as article for CycleBlz, UK Bicycle Trade journal)*, web access <<http://chester.academia.edu/PeterCox/Papers>>, accessed 25 May 2011
- Cox & Van De Walle (2004) *When is a bicycle not a bicycle? Velomobiles and the Modelling of Transport Technologies*, Paper for Conference on Cycling and the Social Sciences, Centre for Mobilities Research, June 29 2004, Lancaster University, UK
- Csikszentmihalyi, M. (1997) *Creativity: Flow and the Psychology of Discovery and Invention*, Harper Collins, Hammersmith
- Dewey, J. 1934. *Art as Experience*. Pedigree, New York
- Douglas, M., Isherwood, B. (1979) *The world of goods*, Basic, New York, p4
- Earnest, L. (1995) *Human Power*, Volume 12, Issue 2, IHPVA, fall 1995
- Fehlau, G. (2003) *The Recumbent Bicycle*, Out Your Backdoor Press, Williamston, MI, USA
- Franklin, A. (2007) *Stylistic Arythmia: making something 'cool'*, Interviewed by Alan Saunders, *By Design*, Radio National, ABC, Wednesday June 23 2007, 3pm, Accessible at <<http://www.abc.net.au/rn/bydesign/stories/2007/1953501.htm>>, accessed June 3 2011
- Franklin, A. (2010) *City Life*, Sage Publications Ltd, London, UK
- Fuchs, A. (1998) *Trim of aerodynamically faired single-track vehicles in crosswinds*, Published in the proceedings of the 3rd European Seminar on Velomobiles, August 5 1998, Roskilde, Denmark

- Goldsmith, S. (1983) *The Readymades of Marcel Duchamp: The Ambiguities of an Aesthetic Revolution*, *The Journal of Aesthetics and Art Criticism*, Vol. 42, No. 2 (Winter, 1983), pp. 197-208 Published by: Blackwell Publishing on behalf of The American Society for Aesthetics, Stable URL: <http://www.jstor.org/stable/430663>, Accessed: 07/06/2011
- Gotshalk, D. W. (1954) *Aesthetic Expression*, *The Journal of Aesthetics and Art Criticism*, Vol. 13, No. 1 (Sep., 1954), pp. 80-85 Published by: Blackwell Publishing on behalf of The American Society for Aesthetics Stable URL: <http://www.jstor.org/stable/427019> .Accessed: 07/06/2011
- Gunderson, P. *Danger Mouse's Grey Album, Mash-Ups, and the Age of Composition*, *Postmodern Culture*, Volume 15, Number 1, September 2004, <http://muse.jhu.edu/journals/postmodern_culture/summary/v015/15.1gunderson.html>, accessed 10 June 2011
- Hebdige, D. (2002) *Subculture: the meaning of style*, Routledge, London & New York: Taylor & Francis e-Library ed.
- Kita, J (1997). *The unseen danger (Special report: impotency and cycling)*, *Bicycling*, August, 68-73.
- Kleine, R., Kleine, S., Kernan, J., (1993) *Mundane Consumption and the Self: A Social-Identity Perspective*, *Journal of Consumer Psychology*, Volume 2, Issue 3, 1993, <<http://www.sciencedirect.com/science/article/pii/S1057740808800150>>, Pages 209-235, accessed June 3 2011
- Koelle, C. (2010) *Bike Snob Nyc*, Cronicle Books, San Francisco, United States
- Krane, H. (1972) *The Third Culture*, Gold Star Publications, Hawthorn, Australia
- Krausse, J., Lichtenstein, C. (2001) *Your private sky: discourse : R. Buckminster Fuller*, Lars Müller Publishers, Museum of Design, Zurich, p229
- Kyle, C. (2010), *The Bicycle, Solar Cars and Human Powered Aircraft*, a talk given for the UC Davis Mechanical and Aeronautical Seminar Series in the Spring of 2010, Film by the UC Davis Engineering distance learning program, audio visuals produced by Chester R. Kyle, Janet Neff, Jason K. Moore, University of California, Davis, United States
- Lanham, D. (2003) *The Hipster Handbook*, Anchor books, New York
- Lumenlab, 2008, <http://www.lumenlab.com/wiki/index.php?title=DIY_Projector_Guide>, accessed 10 June 2011
- McDonough, W. and Braungart, M., (2002) *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press, New York.
- Marks, A. (1989), *The Sinclair C5 – An Investigation into its Development, Launch and Subsequent Failure*, *Journal of European Marketing*, Volume 23, Issue 1, MCB University Press Limited, pp61-71
- Mason, M. (2008) *The Pirates Dilemma: how youth culture reinvented capitalism*, Free Press, New York, Kindle edition, chapter 1
- Martin, G (1984). *Notes on human powered practicality*, In *Proceedings of the Second International Human Powered Vehicle Scientific Symposium*, pp1 1 5-117; 103 Long Beach, CA: IHPVA, Box 2068, Seal Beach, CA.
- Manovich, L. (2009) *The Practice of Everyday (Media) Life: From Mass Consumption to Mass Cultural Production?* *Critical Inquiry*, Vol. 35, No. 2 (Winter 2009), pp. 319-331, The University of Chicago Press Stable URL: <http://www.jstor.org/stable/10.1086/596645> Accessed: 03/06/2011

- Mehta, R. and Belk, R. (1991) Artifacts, Identity, and Transition: Favorite Possessions of Indians and Indian Immigrants to the United States, *The Journal of Consumer Research*, Vol. 17, No. 4 (Mar., 1991), Published by: The University of Chicago Press pp. 398-411, Article Stable URL: <<http://www.jstor.org/stable/2626835>>, accessed June 3 2011
- Mollinari, L. (2005) Buckminster Fuller: Designing for Mobility, Skira Editore S.p.A, Milano, Italy
- Motro, R. (2003) Tensegrity: Structural Systems for the Future, Kogen Page Science, London, p27
- Papanek, V. (1972) Design For The Real World, Themes and Hudson, London
- Parkin, J., Riley, T., Jones, T., 2007, Barriers to Cycling: An Exploration of Quantitive Analysis, Chapter 3, Cycling and Society, Edited by Horton, D., Rosen, P., Cox, P., Ashgate Publishing Company, Burlington
- Parkin, J., 2004, Determination and Measurement of Factors Which Influence Propensity to Cycle to Work, PhD Thesis, The institute of Transport Studies, The University of Leeds; as cited in Parkin, J., Riley, T., Jones, T., 2007, Barriers to Cycling: An Exploration of Quantitive Analysis, Chapter 3, Cycling and Society, Edited by Horton, D., Rosen, P., Cox, P., Ashgate Publishing Company, Burlington
- Pirsig, R. M. (1989) Zen and the Art of Motorcycle Maintenance, Bantam Press, London
- Pountain, D., Robins, D. (2000) Cool Rules: Anatomy of An Attitude, Reaktion Books Ltd, London, p127, 142
- Rasmussen, G. (2009) Velomobile aerodynamics – side wind effect and operation limits, 6th Seminar on Velomobile Design, Copenhagen, 16 - 17 October 2009
- Reiser, R., Peterson, M. (1998) Lower extremity output in recumbent cycling: a literature review, Human Power, Technical Journal of the IHPVA, Volume 13, Number 3, Summer/Fall 1998, pp6-11
- Reprap, 2010, <http://reprap.org/wiki/Main_Page>, accessed 10 June 2011
- Rosen, P. (2002) Up the Vélorution: Appropriating the Bicycle and the Politics of Technology, SATSU Working paper N24 2002, Now published in: (2002) Appropriating Technology, edited by Ron Eglash, Julien Bleecker, Jennifer Croissant, Rayvon Fouché & Giovanna Di Chiro. University of Minnesota Press
- Richardson, M. (2007) Redesign: Design for Reassembly, IASDR07 International Association of Societies of Design Research, Hong Kong Polytechnic University, 12 - 15 November 2007
- Richardson, M., Vittouris, A., Rose, G. (2010) Socialised transport: Increasing travel mode diversity through open-source vehicle design, upcycling, natural production and distributed production methods, Australasian Transport Research Forum 2010, Bureau of Infrastructure, Transport and Regional Economics, Canberra, Australia
- Richardson, M. (2011) Design for Reuse: Integrating Upcycling into Industrial Design Practice, International Conference on Remanufacturing, ICOR, Glasgow, 2011
- Schmitz, A., (1994) Why Your Bicycle Hasn't Changed for 106 Years, Human Power, Technical Journal of the IHPVA, Summer – Fall, vol. 11, no.3, p3-9
- Shusterman, R. 2000. Pragmatist Aesthetics: Living Beauty, Rethinking Art, 2nd ed. Rowman and Littlefield, Botson, MA.
- Thornton, K. (1994) Salvo in Germany - Reiner Pilz, SalvoNEWS No99, 11 October, p14
- Van Der Walle (2004), The Velomobile as a Vehicle for more SustainableTransportation: Reshaping the social construction of cycling technology, Masters of Science Thesis,

PUUNK my ride: development of the Personalised User-generated Upcycled N-configurable Kit velomobile.

supervised by Christer Sanne, Kungliga Tekniska högskolan Royal Institute of Technology, Department for infrastructure, Stockholm, Sweden

Wilson, DG, Forrestall, R, & Hendon, D (1984), Evolution of recumbent bicycles and the design of the avatar bluebell, In Proceedings of the Second International Human Powered Vehicle Scientific Symposium, pp92-103. Long Beach, CA: IHPVA, Box 2068, Seal Beach, CA.