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Product standards as a barrier to innovation: the case of jockey's safety vests

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Abstract: Innovation is key to enhancing product performance and customer benefits, with designers having a core role in conceiving and actioning innovations in response to evolving conditions of use and customer needs. This paper discusses the scope for innovation in jockey's safety vests in relation to the constraint of official product standards. The Australian standard for jockey's safety vests, ARB 1.1998, has not been appreciably updated since the early 2000s despite a consistent rate of serious injuries to jockeys, grown in the number of females and the rise of smart wearable technologies in other sports and health. For this product category, those setting standards seem habitually unable to revise their norms, limiting product development to styling. We complete the paper with a snapshot of results from a program of user research, which shows how jockey's needs and perspectives contest the existing standards for safety vests and could significantly inform product innovation.

Keywords: jockey's safety vests; personal protective equipment; product innovation; safety standards; design innovation

1. Introduction

Product standards have limited innovation in the design of jockey's safety vests in Australia despite consistent rates of serious and fatal injuries to jockeys and the growing participation of female jockeys in the sport. This case study reflects on the barriers to innovation in jockey's safety vests. Firstly, we clarify the nature and purpose of safety equipment in sport. Secondly, we provide brief literature reviews on race injuries to jockeys and the effect of product standards on innovation. Thirdly, we report a qualitative study on the perspectives of jockeys in their use of safety vests to highlight the scope for innovation and limitations of current product standards. Here, we identify the previously unconsidered status of medical staff as an additional user group, whose role in racing accidents is pivotal to the wellbeing of jockeys. We conclude the paper by considering how smart technologies could advance innovation in this product category.



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2. Background to horse racing and PPE

Personal protective equipment (PPE) plays an essential role in preserving athletes' safety when participating in sport. Because of the diverse nature of sports and sporting injuries, PPE is a broad product category that includes helmets, body protectors, gloves, goggles and mouth guards, with athletes often required to use a combination of equipment to offer full protection (Daneshvar, Baugh, Nowinski, McKee, Stern, and Cantu, 2011; Graham, Rivara, Ford, and Spicer, 2014). The PPE literature discusses how design innovation and advanced materials have been applied to PPE design to offer enhanced protection to athletes, although there is no specific literature on the design of jockey's safety vests. According to Sports Medicine Australia (2008), about 50% of sports injuries are preventable with appropriate and properly fitted protective equipment, clothing and footwear. Race riding is well-acknowledged as a risky activity. Regardless of a jockeys' training and skill, it is not possible to prevent a fall; horses are unpredictable animals that have evolved to use agility and speed to escape danger; riding them at speed is inherently dangerous (Miko, 2017).

Despite it being compulsory for jockeys to wear gloves, helmets, goggles and safety vests, jockeys are daily exposed to high risk in races and training gallops, knowing they are likely to experience falls and consequent injuries during their career (Polkinghorne, 2016b). Indeed, former jockey Brian Rouse describes race riding as "like driving a car with no brakes. If you make a mistake, you can't rectify it in one stride" (Quoted in Oakley, 2013, p. 288). In Australia, an average of 200 jockeys are injured annually, 89% of falls requiring medical assistance with 40% of jockeys being unavailable to ride for an average of five weeks a year due to injury (National Jockeys' Trust, 2017). The most common injuries to jockeys are fractures and soft tissue damage, but the most serious are head and spinal damage, which can cause permanent, debilitating injuries and even death (Mackey-Laws, 2016; Aitken, 2017; Johnston, 2017, O'Connor, Warrington, McGoldrick, and Cullen, 2017). The catastrophic injuries often suffered by jockeys in the torso area following falls (Filby, Jackson, and Turner, 2012; McCrory, Turner, LeMasson, Bodere, and Allemandou, 2006) highlight the poor level of protection offered by safety vests.

The major international industry that provides clothing and equipment for riders is an interesting case in what motivates product development. Horse riding is often a pursuit of social elites, with *fashionability* being a significant consideration for the design of riding attire and equipment. This is followed by comfort and lightness, with all three played off against protection from injury. For example, the expensive helmets worn by female dressage and show riders often feature detailing in luxury materials such as python skin and Swarovski crystals in the aim of creating a glamorous appearance for the rider, with protection from injury being a secondary factor.

Even where PPE for equestrian sports is not dominated by fashion, effective design can meet significant constraints. The market for PPE for equestrian sports and leisure activities sees the proportion of amateur riders vastly outnumber professional riders. Jockeys form a small niche group within the totality of riders who might need or want to wear a safety

vest. Jockeys' safety equipment needs to be especially light and also accommodate jockeys' very light build and small stature. The weight that horses carry in a race is limited to enable them to perform without being overly taxed. Jockeys work hard to keep their body weight as light as possible, ideally between 49 and 54kgs, while they ride horses that weigh between 500 and 600kgs. In handicap races, varied weights are allocated to horses based on past performance to equalise the horses' chance of winning and make wagering on races less predictable. For example, the minimum weight allocated for handicap flat races such as the Melbourne Cup and Caulfield Cup must not be less than 50Kg while the top weight must be not less than 58Kg (Racing Australia, 2020, p.79-80), the total comprising the weight of the jockey, their gear and the racing saddle.

3. Injuries in race riding and the introduction of safety vests

In race riding, jockeys ride horses galloping in a group at a speed of around 60 K/h (Miko, 2017). Jockeys' precarious riding position presents an added challenge, seeing them adopt the "Martini glass" posture where their centre of gravity sits over the horse's shoulders to minimise the effect of the jockey's weight on the horse's forward momentum (Figure 1). To achieve this, jockeys ride with very short stirrups attached to a miniscule saddle. This sees them perched on top of the horse in a crouch position with only their lower legs in contact with the horse's body. When an incident occurs, jockeys are extremely vulnerable to falls. In addition, multiple horses can fall at the one time, exposing jockeys to the risk of being crushed or trampled by their own horse or those following (Navarra, 2015).

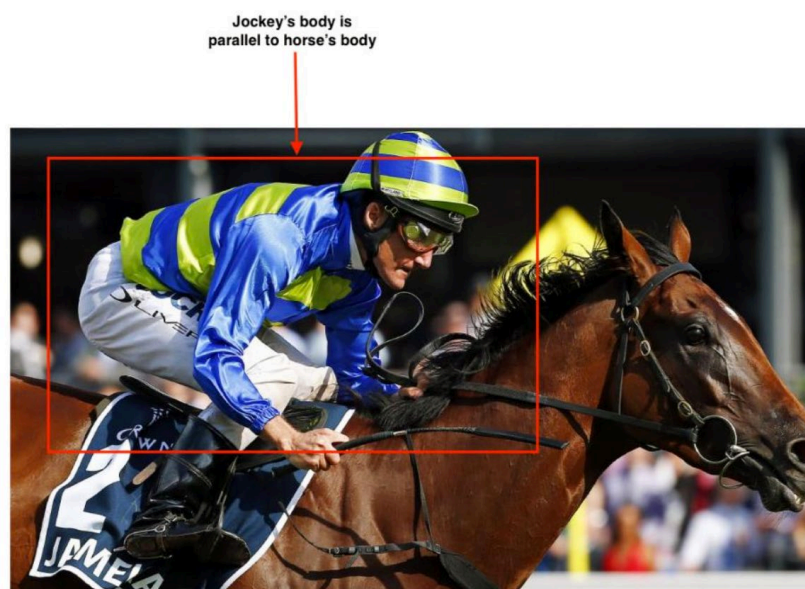


Figure 1 "Martini Glass" riding style during a Caulfield Cup (Stewart, 2016)

In Australia, jockeys who ride in flat races experience an average of one fall every 240 rides, with a third of falls resulting in injury (Hitchens, Blizzard, Jones, Day, and Fell, 2009). Approximately 200 riders are injured annually on Australian racetracks, the combination of

race riding and track work producing around 500 falls per year; the average work time lost due to falls will exceed 500 hours per incident; over their careers, 9% of Australian jockeys experience more than 20 falls, with 5% of falls resulting in career-ending injuries (National Jockeys' Trust, 2017). Due to the risks that jockeys face, doctors and paramedics attend all race meetings to monitor the wellbeing of riders. During races, ambulances follow the field on an adjacent track. These are staffed by a doctor, two ambulance officers and a registered critical care nurse ready to immediately attend to jockey following a fall (Racing, 2008; Australian Harness Racing, 2015; Wilson Medic One, 2015).

To try to reduce the severity of jockeys' injuries, in 1995 the Australian Racing Board commissioned a collaborative study between doctors and engineers to investigate how best to protect jockeys (Gibson, 1996, 1998; McLean, 2004). Based on this study, in 1998 the Australian Racing Board made the use of safety vests compulsory and introduced the Australian standard ARB 1.1998 to which safety vests had to conform. ARB 1.1998 is closely aligned with the European Standard EN 13158, developed in 1986 to address wide variation in jockeys' safety vests, thus establishing minimum standards for coverage of the torso, manufacture, product testing and performance. The reason for developing a separate Australian standard was the perceived climatic differences between Australia and Europe. ARB 1.1998 is certified by Standards Australia. It determines that safety vests are made of perforated foam strips of varying thickness, covered with mesh polyester. Adjustable strips or Velcro® sections at the shoulders and waist keep the vests tight on the jockeys' bodies. Within ARB 1.1998, only two safety vests templates are available, these having to accommodate male and female jockeys of varying body types and sizes.



Figure 2 Level 1 jockeys' safety vests approved by ARB (Giusti Gestri, 2019)

Notwithstanding the reduction in the number of jockeys' deaths since the introduction of the compulsory use of safety vests, their effectiveness has come under sporadic criticism. Roe et al. (2003) call for the efficacy of safety vests to be evaluated alongside a safety education program being introduced for all horse riders. Doubts about the validity of the product standards for PPE for jockeys were raised in 2011 by an Australian report that analysed the injuries and risk factors suffered by jockeys (Foote et al., 2011). It noted a paucity of data about the incidence and type of injuries sustained by jockeys in thoroughbred racing. While confirming the importance of wearing safety vests and helmets, Foote et al. (2011) criticised the variety of standards covering PPE for jockeys. Today, safety vests for jockeys must comply with ARB Standard 1.1998 or European Standard EN 13158, while jockey's helmets must comply with AS/NZS 3838 2006; EN 1384:2012 or EN 1384:2017; ASTM F116 3-04a (2011), ASTM F1163-13 or ASTM F1163-15; PAS 015:2011; VG1 01.040, Recommendation for Use, 12/12/2014 (Racing Australia, 2020, p.63).

3.1 Product Standards

Geng (2019) notes the problem of product standards that span both national treatment and mutual recognition across national borders. Such arrangements mean companies need only observe the lowest common denominator in product standards: Geng questions how different principles in product standards agreements are chosen and, most critically, whether "these choices [are] well-founded from a welfare perspective" (2019, p. 1258). Geng observes that product standards established in high income nations and trade blocs — where consumers expect high product quality — can raise product standards in other jurisdictions and lessen the negative impact of products, but he argues that harmonising standards is difficult. Because the two main safety products used by Australian jockeys need to conform to a range of standards, there is inherent potential for negative interference between standards. Stipulations for one product category can affect the design and performance of the other, this interaction building complexity into the delivery of user-specific solutions for individual products. How the neckline of safety vests interacts with helmets due to jockeys' typical riding position is an example.

In the case of safety vests, the Australian standard ARB 1.1998 has had minimal revision since its introduction, significantly limiting the scope for improvement and lessening the need for manufacturers to compete through product innovation. Minor changes have not greatly benefitted users, the standards review process revealing no appetite for innovation. For instance, no new advanced technologies developed since the introduction of the standard such as smart fabrics or sensors have been integrated into its criteria or into vest designs for jockeys. Changing contextual factors suggest the need for significant revision. High among these is the fact that the number of female jockeys has risen significantly since the introduction of ARB 1.1998 (Norton, 2015; Parke, 2018). The prediction is that at some point between 2018 and 2028, female jockeys will outnumber male jockeys (Cook, 2018). This alone indicates a strong need for attentiveness to the ergonomics of vest design, existing product standards for jockeys' safety vests failing to allow for alternative designs to fit male and female bodies.

3.2 Vests regulations as a barrier to innovation

Since 1998, jockeys' riding style has continued to evolve to see them use ever shorter stirrups, exaggerating their crouched position, something rarely cited in literature. Climate change has increased the risk of heat stress and discomfort for Australian jockeys when wearing vests, extending discomfort experienced over more of the year. Despite the recent introduction of inflatable vests as PPE for horse riders in general, these devices have not been considered for race riding. Although they have received evaluation, only a small number of riders wear them (Meredith, Ekman, and Brolin, 2018), suggesting resistance from riders to innovation, perhaps due to the constraints on change in PPE because of product standards.

A number of studies on the frequency and nature of injuries to jockeys call for more effective safety vests (e.g. Moss, Wan, and Whitlock, 2002; Yim, Yeung, Mak, Graham, Lai, and Rainer, 2007). McCrory et al. (2006, p. 618) specifically argue that safety vests do not protect the spinal column from the compressive injuries often experienced in race falls. A pilot study by Brolin and Wass (2016) assessing the protective capacity of jockeys' safety vests in a range of scenarios found that the vests offered good protection against horse kicks, with the chest withstanding 125 to 175Ns compared to no vest worn at 225Ns. However, the vests tested provided no protection in rotational falls where a horse lands on top of a rider, a common accident in racing. In simulating the condition of being trampled by a horse, Brolin and Wass found that the risk of injury was far higher for hoof impact close to the sternum compared to more lateral locations, which had up to 25% less risk.

3.3 Need for safer vests

A range of articles call for specific consideration of the *design* of safety vests for jockeys (Gibson, Thai, Saxon, and Pollock, 2008; Foote, McIntosh, V'Landys, and Bullock, 2011; Safety Solutions, 2014). The vests in use are described as bulky and stiff, and thus restrictive and uncomfortable to wear with a need for jockeys' perspectives to be feed into product development being recognised. Although wearing PPE is seen to have reduced the number and severity of impact injuries to the jockey's to an extent, the literature identifies that in an emergency situation — where jockeys need medical attention on the track following a fall during a race — PPE can obstruct access to the chest, face and head, interfering with the ability of medical crews to properly stabilise jockey's spine or head. Here, Casa and Stearns (2015) highlight the problem of obstruction where immobilisation on a spine board is needed.

A two-year investigation into the protective capacity of safety vests funded by the Australian Racing Board and the Rural Industries Research and Development Corporation produced the report, "*Evaluation of Safety Vests – Health and Safety in Australian Racing*" (Foote, Gibson and McGauran, 2014). It determined that of international standards for safety vests, ARB 1.1998 offered the lowest level of protection although its testing for impact performance was the most complete. The report recommended improvements in safety vest design

and revision to the Australian standard based on Australian weather conditions and the type of injuries sustained by Australian jockeys. The report included insights gained from an anonymous survey of Australian jockeys, which indicated their dissatisfaction with the performance of the vests in terms of protection, heat retention, their restrictive nature and lack of flexibility due to the materials used. It concluded that to foster improvements in the design and performance of safety vest more research was required, including specific input from jockeys. Hitchens (2014) and Andres, Bushau-Sprinkle, Brier and Seger (2018) make similar arguments. Despite such conclusions, no changes have been made to ARB 1.1998 to address these perceived deficits.

4. User Research: A catalyst for breakthrough innovation?

In response to the constraints on innovation in the design of jockey's safety vests, the first author conducted a program of field research in 2016/17 to understand jockeys' and medical first-responders' perceptions of the safety vests mandated for use by Australian jockeys. The study used a flexible, qualitative research design incorporating semi-structured interview, focus group and observation. The research design was informed by Forlizzi's (2007) concept of product ecology, of which she writes:

The Product Ecology framework articulates all of the factors that evoke social behaviour around products. The factors in the framework can be used in a generative manner to scaffold the selection of design research methods for understanding current experience and generating new products to change that experience ...[It] provides an alternative way of understanding the complex physical and social context of use around a product, and a means for suggesting change within the current state of the world. (p. 18)

For Forlizzi, application of a Product Ecology framework can expand the sense of what a product *is* and what it *could be*, hence its value in being applied to develop insights to contest the representation of a product in a long-established product standard.

4.1 Research method

To create a deep understanding of how jockeys experience safety vests and what they mean to them, data gathering involved the primary users of the vests, the group of participants being comprised of apprentice jockeys (n=6), fully qualified jockeys (n=9) and former jockeys (n=2). However, drawing on Forlizzi, a secondary user group was included — the medical staff who handle the safety vests when jockeys are injured. Two doctors and one intensive care paramedic were included in the study for a total of 20 participants. 16 of the 17 jockeys interviewed had experienced at least one fall during their career when wearing a safety vest (see Table 1). The three medical professionals had significant experience in treating jockeys' injuries after falls. They considered that making safety vests compulsory had been beneficial for jockeys, but their involvement offered unique insights into design limitations in the current vests resulting from their experience in attending to jockeys in the critical period after a fall when quick decisions had to be made about whether to remove the vest from an injured jockey.

Table 1 Participants' racing and fall experiences

Participant Code	Category	Gender	Experience in years	Falls	International Races
AJ 01	Apprentice Jockey	M	5	Yes	No
AJ 02	Apprentice Jockey	F	4	No	No
AJ 03	Apprentice Jockey	M	2	Yes	No
AJ 04	Apprentice Jockey	M	3	Yes	No
AJ 05	Apprentice Jockey	M	3	Yes	No
J 01	Jockey	F	6	Yes	No
J 02	Jockey	M	21	Yes	Yes
J 03	Jockey	M	24	Yes	Yes
J 04	Jockey	F	28	Yes	Yes
J 05	Jockey	M	30	Yes	Yes
J 06	Jockey	M	18	Yes	Yes
J 07	Jockey	F	5	Yes	Yes
J08	Jockey	F	18	Yes	Yes
D 01	Doctor	M	28	n/a	n/a
ICP	Intensive Care Paramedic	M	3	n/a	n/a
D 02	Doctor	M	10	n/a	n/a
AJ 06	Apprentice Jockey	M	3	Yes	No
J 09	Jockey	M	16	Yes	Yes
JR 01	Retired Jockey	M	28	Yes	Yes
JR 02	Retired Jockey	M	12	Yes	Yes

Once individual semi-structured interviews were completed, a preliminary analysis of the interview data was undertaken (Attride-Stirling, 2001). This used thematic analysis with the assistance of NVivo software. The findings of the preliminary analysis informed the conduct of the focus group. This provided a form of member checking by testing the trustworthiness of the interview results with the research participants (Dey, 2003). In the light of the interview and focus group results, participant and non-participant observation was conducted at three major city racecourses in the state of Victoria, Australia, in order to develop deeper understanding of the design context and jockeys' and medical first responders' experience of safety vests. The first author was able to watch the participants in their normal environment around the track, in the jockeys' room, the press room, the main community room and the weights room. More observation was performed at Victoria's Apprentices School and at fitness sessions at Exercise Research Australia (ERA). Observations were recorded with notes and some photographs.

4.2 Field research and observations

Such is the constraining effects of the product standard ARB 1.1998 that the participants were surprised that they were being asked about their experience of safety vests, commenting that they had often tried to provide feedback on them, but had been ignored. They were enthusiastic about sharing their stories with a researcher about their falls, injuries and discomfort while wearing the vests, as well as their perceptions of the limitations of current vests. The jockeys were conscious that their profession was extremely risky. They also accepted the products on the market, even if they did not guarantee their safety. As one jockey explained,

For what we do there is always no guarantee And again, the perception is not that we expect the vest to save our lives All we want it to do is to help us, not hinder us in a racing incident”

The jockeys described in detail their feelings of restriction when wearing the vests, attributing this to a system that had not paid attention to their concerns or involved in the development of standards for vest design. As indicated in the jockey’s comment above, limited movement is a serious problem for jockeys. They need to bend their heads, turn to look around for other horses, talk to each other during races and be able to roll into a ball in the case of a nosedive fall — a common form of tumble where jockeys can be flung forward into the ground.

4.3 Data analysis

Most of the participants reported that the vests were uncomfortable due to their rigidity and felt hot and even heavy to wear. The female jockeys commented that the safety vests worn during track work, which are not covered by ARB 1.1998, are more comfortable than those required for racing. They explained that those worn for track work are heavier, but softer. This increases their comfort because the vests tend to mould to their body shape. As one female jockey explained,

From a female’s point of view or perspective, I think definitely they need to have a male and a female vest. That’s my opinion. They do it with all the motorbike gear and all that sort of stuff. The only reason I know is because I used to ride a lot of dirt bikes when I was younger. There’s a big difference with the female body suits compared to the male’s body suit. Obviously, we’ve got our breasts and our hips and stuff – our curves [motorbike gear] was all fitted. It was completely different”. With the safety vests worn during racing seen as a source of discomfort, several participants reported wearing the safety vests differently to how they were meant to be worn, for instance, leaving the vest a bit looser on the sides or even wearing them backwards.

Many of the participants highlighted the problems they encountered as the vests came into contact with their race helmets, highlighting an issue with the interaction of standards. Most helmet manufacturers have no connection with those producing safety vests. The standards to which helmets must adhere do not take into account those used for safety vests. The lack of research into the conditions of use has created the risky situation that during a race, the

top of the safety vests can into the back of a jockey's helmet. Most participants reported that the vests interfered with their helmets, leading to bigger problems such as their vision being impaired while riding. As one participant explained,

I am not watching where I am going because I have to look with my eyes up instead of my head up ... I can feel it pinching on the back of the vest, so it is just half an inch, so it is stopping me from extending my neck forward. Jockeys cannot extend forward properly because vest and helmet bump together.

This effect becomes most critical during the last 400 metres of a race when the jockeys urge their horses up to their maximum speed to try to win, with a pack of horses jostling each other to get to the finish line first.

The jockey's perceptions and experiences lead them to express doubts regarding the knowledge of those who established and maintained the safety vest standard ARB 1.1998. Jockeys with more years of experience were the most critical as they had encountered the problems with the vests for the longest time without anything changing. One simply stated, "I don't know how they do the standards." while another expressed clearer doubt in commenting, "I am not convinced the standards are right." A third participant voiced their perception of the source of the problem in stating,

The people doing the test might be engineers and experts in testing equipment, but they are not experts in riding, racing, or dealing with the animals or what we deal with. They are only dealing with numbers, facts and obviously video footage, but they are not the people actually riding, or the ones actually falling in it.

The medical professionals discussed the nature and severity of the injuries they treated and the ways in which the safety vests interacted with their actions. They reported that after a fall, the time a jockey spends lying on the turf is crucial. Here, medical attendants need to act fast and with accuracy. Unfortunately, the vests' design represents an impediment to the rapid supply of aid because they are hard to remove. The medical participants showed curiosity for the research process because, finally, someone was trying to investigate such an important matter, with scope to bring improvements to how they carried out their work. Both the jockeys and the medical staff considered that the most dangerous place to be fall was at the starting barriers or at full gallop while perched above the saddle. The medical participants observed said that the vest designs were not exactly fit for purpose, because during a fall, a jockey's chin often came forward and caught in the top of the vest, thus adding to a jockey's injury.

4.4 Results and insights

Generally, the jockeys regarded safety vests as compulsory items rather than essential and desired equipment to guarantee their wellbeing. To balance safety and comfort in the provision of safety vests, there are two options: 1) to use current technology to improve an existing product design or 2) employ a radical approach. Each of these choices has its advantages and disadvantages (Fullagar, 2015). An incremental innovation approach has the

advantage that the product remains competitive and acceptance of any change is easier in being delivered via an already recognisable product. Revisions to an existing design can be implemented at a reasonable price and if successful can be marketed to a large market of recreational and competitive riders in addition to jockeys.

In the design of safety vests for Australian jockey, the opportunities for incremental improvement span addressing the:

- basic and rigid design;
- paucity of ergonomics;
- lack of advanced materials and technologies;
- the spinal area not being adequately protected;
- absence of a user-centred design approach to enhance marketability;
- providing alternative designs for male and female jockeys.

A radical innovation approach offers the opportunity to create whole new products and markets, opening the door to new innovative PPE companies to enter the marketplace. Eventually, radical product innovation may be the only answer to most of the deficits that jockeys attribute to safety vests as the current designs enabled by the current standards may be too compromised to be sufficiently adapted. Reflecting an aim of the application of the Product Ecology Framework, a key consideration in the opportunity for radical evolution in safety vest design is in approaching them not simply as personal protective devices, but as first aid tools for treating medical staff.

The term “wearable technology” refers to accessories and garments created to incorporate electronics. These products can collect and monitor data about a user or the surrounding environment through their proximity to the human body. The high demand for smart technologies has seen analysts forecast the sale of 411 million smart wearable devices in 2020 at a value of around US\$34 billion (Lamkin, 2017). Smart wearable products are successful when they achieve a balance between interaction design, technology, comfort and purpose. If these criteria are satisfied, a product that adds value to users’ lives is achieved. In the case of the re-conception of jockey’s safety vests through the application of sensors, there is potential for critical information on the location and severity of impact in a fall or contact between the horse and jockey to be transmitted to the attending medical officers at the track, thereby permitting faster and more informed medical assistance. Such information could also be sent ahead to emergency department staff at a hospital waiting to receive an injured jockey.

5. Conclusion

Race riding is a dangerous occupation, yet in Australia, current safety vests are inadequate to the task of preventing jockeys’ injuries. Jockeys want and deserve safety vests that incorporate the best possible mix of comfort and safety. Achieving this outcome involves ongoing scope for new designs to be introduced to the market, this being especially likely

in the light of constant innovation in materials and digital technology. Nowadays, wearable technologies are making strong inroads into sports, being associated with enhanced functionality and design. Yet as our paper has argued, neither incremental nor radical product innovation is currently possible in Australia because of the constraining effects of the product standard ARB 1.1998, its criteria being only minimally and rarely revised over the past two decades. Introducing a new design could offer a higher level of safety and comfort; a revision of the neck cut (both front and back of the vest) represents a scenario in which the standards would be reinterpreted to develop related standards for vest and helmet. Product innovation may bring benefits to the medical professionals in reducing the time in removing vests from injured jockeys. Our paper has identified the additional problem of a lack of alignment between standards for products that interact during use as well as the challenge of adapting international standards to reflect local conditions such a climate and turf conditions in the case of safety vests for jockeys.

Most significantly, the application of the product design framework to the ethnographic research identified that more than one category of user should be considered as active in the product context. Not only was the significance of differences between female and male jockeys in their experience of safety vests identified. A new category of vest user was revealed in the form of medical staff. These users cannot be adequately characterised as secondary, which is to say lesser users relative to jockeys, nor as stakeholders. Their role in the ecology of use and the fate of jockeys following a fall is crucial. Their inclusion in the future improvement of vest designs and related product standards is critical. Hence, they are more properly characterised as co-dependent, or even co-primary users, in the successful use and evolution of jockey's safety vests.

Innovation is clearly required to enhance the function and experience of safety vests for jockeys. Our paper has argued that research informed design should include jockeys and medical staff as the main protagonist, not only to deliver improved vest designs, but to serve as a catalyst for the revision of safety vests' standards in ways that are dynamic and context specific.

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