# Disruptive Innovation in “RASBOARD” Vehicle in Sports Practice in DOWNHILL Based in New Control System in Direction and Brakes

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***Abstract*—The purpose of this thesis is to apply an action research methodology used to guide a sports invention towards sports innovation, and to be presented as a new sport. Although the stage developed in R + D was very successful, these results imply a greater differentiated effort as it is R + D + i. Thus, two central objectives were proposed: a) to identify the target population and the sports context that encourage research, b) to propose on the use of strategies to organize and promote innovation. The result of the investigation offers a new solution, registered as “Rasboard”. The thesis proposes strategies for innovation in downhill sports practice. The same ones that can generate the opening of a new market in a new recreational and sports activity.**

***Index Terms*—Extreme sports, technological development in sports, innovation in sports, innovation strategies.**

## I. INTRODUCTION

The methodologies and strategies of innovation are presented towards a new sports equipment that has greater stability and control to be used on slopes. Extreme sports are a common practice for being fun and full of adrenaline. Unfortunately, these could lead to many accidents; from minor injuries (sprains and broken limbs), to serious injuries (skull and spine fracture). Many of them present complications that, in the long run, degenerate into disease and even death.

The study, in general, offers solid strategy proposals, outlining the high expectations that may result in the opening of a new market within the Latin American context, starting in the main Peruvian regions. In the same way, the business model that will start this new sporting activity is proposed. All these projections have been obtained throughout a study, and a vast development presented in this research.

### A. *Gravity Driven Lean to Steer Wheeled Vehicle*

The invention relates to a gravity-driven vehicle that is most often used on inclined surfaces. The skateboard is characterized by a structure mounted on two pairs of wheels, a padded seat with backrest, two side handles, and a curved leg rest screwed to the front of the structure. It has a brake pad system, which generates friction with the rear wheels, thus causing the vehicle to stop. The skateboard is to be used in a sitting position with the legs on the leg rest [1]. This patented model is absent on the market.

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### B. *Hoverboard*

It is a type of skateboard, invented in the United States by Arx Pax Labs, Inc., [2]. This motorized skateboard rotates with the help of magnets generating a magnetic lift. The base can be tilted to achieve propulsion in a particular direction. The motors can be coupled to a tilt mechanism, and this can tilt to provide translational forces [3]. This patented model is present on the market.

Most skateboarding accidents (52%) occurred on the street, while hoverboard accidents (66%) occurred at home. The most common cases were head injuries, and fractured wrist and forearm. The sample of the characteristics of hoverboard and skateboard injuries in young people could be considered in implementing preventive measures to reduce the result of injuries, and constant visits to the emergency room. Fig. 1 shows users with hoverboard injuries (light gray), and skateboard injuries (dark gray), by age (in years).

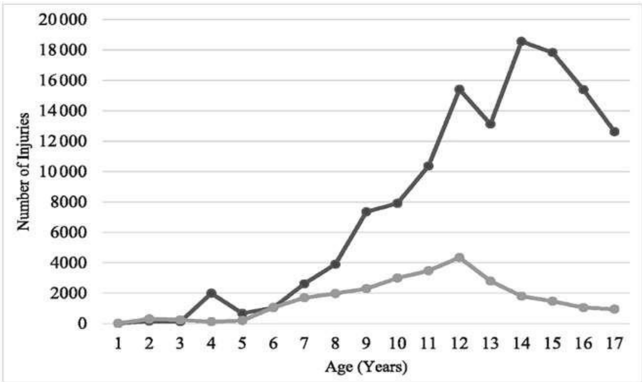


Fig. 1. Hoverboard vs skateboard injuries [4].

Peruvian skateboarding as a sport, became known nationally and internationally with the participation of the national and South American downhill skateboarding champion, Felipe Málaga, who fatally suffered a serious accident at the IGSA 8 World Championship held in South Africa, while he was going around a steep curve in the competition [5].

## II. METHODOLOGY

Between the years 2010-2014, a neurological study was carried out in 51 patients under 18 years of age from the neuroscience department of the Brisbane hospital, Australia, who went through accidents caused by skateboarding. The patients had head and spinal injuries; the numbers mainly being men with 94% affected, the average age of 14.3 years, the type of severity in moderate 70.5% and severe 29.5%, in addition, 16 patients with cranial fracture were treated, and other serious injuries shown in Table I [6].

TABLE I: NEUROLOGICAL INJURIES FROM SKATEBOARDING

| Characteristic | Samples | Percentage % |
|---|---|---|
| Total injuries | 51 | 100% |
| Male | 48 | 94% |
| Female | 3 | 6% |
| Average age | | |
| Years | 14.3 | |
| Gravity type | | |
| Less and moderate | 36 | 70.5% |
| Serious and severe | 15 | 29.5% |
| Specifications | | |
| Skull fracture | 16 | |
| Skull base | 14 | |
| Extradural hematomas | 13 | |
| Craniotomy | 5 | |
| Hemiplegia | 1 | |
| Spinal cord injury / paraplegia | 1 | |
| Other complications | 1 | |

Source: Adapted from information obtained [6]

Downhill skaters, when sliding down slopes at high speeds, can only slow down when the slope is leveling out; that is why, slowing down (speed > 80 km / h) while sliding downhill is totally unlikely. [7].

At the regional level, in Brasilia, the results of a sociology thesis [8] show that 90% of its respondents have been injured at least once, and 47% maintain a chronic injury as a result of injuries caused by skateboard practice.

TABLE II: SKATEBOARD DOWNHILL INJURIES

| Characteristic | Samples | Percentage % |
|---|---|---|
| Total injuries | 287 | 100% |
| Male | 233 | 81.20% |
| Female | 54 | 18.80% |
| Age | | |
| Years | >10 | |
| Location of injury | | |
| Streets and highways | 75.30% | |
| Skateparks | 1,4% | |
| Gravity type | | |
| Head and neck injuries | 23.30% | |
| Neurological trauma | 8,6% | |
| Limb injuries | 24,7% | |

Source: Adapted from information obtained [9]

Downhill skateboarding is a sport with a view to growing in Peru, it has spaces for placement and support from private entities and the government in promoting sports and tourism, however, contrary to this booming sport, accident studies and injuries with disappointing numbers. The International Journal of the Care of the Injured article related to downhill skateboarding in the United States and Canada indicates that the practices are highly risky due to intracranial injuries. The cases carried out in 287 patients, older than 10 years between 2006 and 2010, show that the majority percentage of injured incurs in men with 81.2%, accidents mostly occur on the street and highway with 75.3%, the highest incidence is in limb injuries 24.7%, and secondary, head and neck injuries 23.3% [9] (see Table II).

The method used to design a product is not absolute; it is being modified with other points that can improve the process, that is why the chosen rules do not delay the designer, quite the opposite, it is motivation to generate an original design that can be useful to others. These can have a logical order, following the necessary actions that are directed by experience [10]. The design process must include three stages: Analytical; where information about the needs, the problems to be solved, the limits of the entire project and the terms to be followed are investigated. Creative; with the information obtained, ideas are developed, filtering them between them to conclude in a solution. And finally, Execution; it is at this stage that the proposal is presented to the client, receiving feedback to make variations or improvements, thereby completing the project [11].

## III. RESULTS

The Rasboard is ergonomic [12] (see Table III); the curve protects the user across the length and width, it has a backrest in the back that supports the user's lower back, allowing them to rest comfortably. [13] The shape of the table allows the entire vehicle to rest in a vertical position, since it is supported by the rear wheels when supporting, achieving a stable distribution for storage. It has a rear axle with two wheels and a pair of brakes on them, the brake lever and the side handles can be used simultaneously while traveling on a slope, without having to release said handles, since they are less than 8 cm. of the brake lever [14].

The base surface for the design of the board uses Capirona wood, which has characteristics of medium flexibility 723 kg / cm2 not very rigid, the wood presents not so visible porosities of 13 to 25 pores / mm2. The color of the outer and inner layers of the wood (sapwood - heartwood) is creamy white, which shows a result of a wood with uniform color without layers that contrast the color. Durability is an important factor, and Capirona is a wood resistant to any biological attack and does not require further preservation [15].

The front and rear axle structures use hot rolled LAC (hot lamination) [16], in sizes 2 “wide x 1” high x 1.5mm wall thickness. The entire steel structure is made up of joints in electric arc welding under protective gas with tungsten electrode TIG (tungsten inert gas), this type of welding is used in all positions and in different thicknesses, in addition, it is considered a clean welding because it is free of slag, making it a very versatile process [17]. For the final finish and protection against corrosion, oven paint (electrostatic paint) is applied, which allows better finishes and a highly hard finish. This type of paint maintains excellent adhesion, appears greater visual volume with rounded edges, is resistant to scratches, bumps and ultraviolet rays, optimizing use outdoors [18].

TABLE III: RASBOARD, ERGONOMIC MEASUREMENTS

| Seat | Position of the handles |
| --- | --- |
| Proper seat width. The value of β for the 97.5% percentile is = 1,960; $\bar{x}$ = 35.7 and S = 2.978. | Length that determines the position of the handles. The value of β for the 97.5% percentile is = 1,960; $\bar{x}$ = 82.3 and S = 3.647. |
| $x_p = \bar{x} \pm (\beta p)\ (S)$<br>$x_{97,5} = 35{,}7 \pm (1.960)\ (2{,}978)$<br>$x_{97,5} = 41.53$ cm. | $x_p = \bar{x} \pm (\beta p)\ (S)$<br>$x_{97,5} = 82{,}3 \pm (1.960)\ (3{,}647)$<br>$x_{97,5} = 89{,}44$ cm. |
| The width of the Rasboard seat is 42 cm. $> x_p = 41.53$ cm. therefore, 97.5% of the population will be able to use the seat without problems. | The distance from the shoulder to the handles is 60 cm. $< x_p = 89.44$ cm. therefore, 97.5% of the population will be able to reach the handles without problems. |
| **Position of the feet** | **Grip thickness** |
| Length of legs that determine the position of the feet in the cavities of the frontal axis. The value of β for the 97.5% percentile is = 1,960; $\bar{x}$ = 103.9 and S = 4.984. | Grip thickness (width) that sets the width of the grips. The value of β for the 97.5% percentile is = 1,960; $\bar{x}$ = 4.7 and S = 0.3039. |
| $x_p = \bar{x} \pm (\beta p)\ (S)$<br>$x_{97,5} = 103{,}9 \pm (1.960)\ (4{,}984)$<br>$x_{97,5} = 113{,}67$ cm. | $x_p = \bar{x} \pm (\beta p)\ (S)$<br>$x_{97,5} = 4{,}7 \pm (1.960)\ (0{,}3039)$<br>$x_{97,5} = 5{,}295$ cm. |
| The distance from the seat to the front axis of Rasboard is 80 cm. $< x_p = 113.67$ cm. therefore, 97.5% of the population will be able to reach the cavities in the frontal axis without problems. | The thickness of the Rasboard handles is 1.3 cm. $< x_p = 5.295$ cm. therefore, 97.5% of it will be able to grip the handles without problems. |
| **Hand width** | **Foot width** |
| Hand width that sets the length for the handles. The value of β for the 97.5% percentile is = 1,960; $\bar{x}$ = 8.9 and S = 0.425. | Foot width that determines the size of the cavities in the front axle (rudder). The value of β for the 97.5% percentile is = 1,960; $\bar{x}$ = 9.75 and S = 0.455. |
| $x_p = \bar{x} \pm (\beta p)\ (S)$<br>$x_{97,5} = 8{,}9 \pm (1.960)\ (0{,}425)$<br>$x_{97,5} = 9{,}73$ cm. | $x_p = \bar{x} \pm (\beta p)\ (S)$<br>$x_{97,5} = 9{,}75 \pm (1.960)\ (0{,}455)$<br>$x_{97,5} = 10{,}64$ cm. |
| The length of the Rasboard handles is 15 cm. $> x_p = 9.73$ cm. therefore, 97.5% of the population will be able to hold onto the handles without problems. | The width of the cavities of the front axle (rudder) of Rasboard is 11 cm. $> x_p = 10.64$ cm. therefore, 97.5% of the population will be able to place their feet in the cavities without problems. |

Source: Adapted from information obtained [12]

## IV. VALIDATION

### A. Validation in Context

Rasboard has been tested in locations with various ground conditions and different slopes. First test: skating rink that has a cycle of ascents and descents in different proportions in height and width, located in Miraflores. Second test: Slope at Morro Solar in Chorrillos, with a 3.5 km long track route [19]. Other tests: exhibitions (Global Grad Show Dubai, Geneva Invention Hall, Expopatenta Indecopi, InnovaLima), tours were carried out with those attending these exhibitions (Fig. 2 and Fig. 3).

Fig. 2. Rasboard rink.

Fig. 3. Rasboard morro solar.

The design proposal of the Rasboard vehicle must transmit greater stability and control in the descent, intuitive and youthful in its forms. The parts of the structure are described below: Material; square tube, steel plate, capirona wood, allen bolts, non-slip rubber. Techniques used; in steel, cutting, bending and welding, in wood, cutting, laminated and polished. Functionality; the wheels and brake are joined to the rear axle, the steering mechanism (front axle) has footrests, the table is assembled on the metal frame. Ergonomics; the lumbar area is supported by the backrest achieving comfort and containment, the hands and feet are located in the cavities for a better grip during the slide (Fig. 4 and Fig. 5).

Fig. 4. Rasboard.

Fig. 5. Rasboard parts.

### *B. Laboratory Validation*

Cite Materiales has more than 40 years of experience in materials study services and is internationally certified. Through agreements and research projects, it aims to transfer and expand the technologies of companies, contributing to the development and improvement of productivity [20].

According to the results obtained from the tests carried out in the laboratory corresponding to the Cite Materiales service; it is indicated that the Rasboard vehicle resists the weight of 333.6 kilos, the wood laminate in the longitudinal direction on average 117 kilos, in the transverse direction on average 107 kilos (see Table IV). Specifying that the equipment begins to deform when exceeding this weight. With the present laboratory results, it is determined that Rasboard resists the weight of the target audience, as well as it could be demonstrated in the validation in context.

TABLE IV: RASBOARD RESISTANCE TEST

| Sample | Maximum load (N/kN) | Maximum load (kg-f) |
|---|---|---|
| Equipment: Rasboard Vehicle | | |
| 1 sample | 3302 | 333,6 |
| Material: Wood Laminate | | |
| Longitudinal | | |
| 1 sample | 1,18 | 120,3 |
| 2 sample | 1,13 | 115,2 |
| 3 sample | 1,14 | 116,2 |
| Cross | | |
| 1 sample | 1,01 | 103,0 |
| 2 sample | 1,09% | 111,1 |
| 3 sample | 1,04% | 106,0 |

Source: Adapted from information obtained from Cite Materiales

## V. CONCLUSION

The development of the Rasboard vehicle is a process that takes into account three main systems: mechanical, stability and control. The methodology used was based on primary and secondary research, information collected in context, such as outdoor spaces and laboratories that study the resistance of materials. The form and function results are supported by theoretical studies, stress studies, ergonomic studies, and in-context validations. The implementation of Rasboard shows, a resistant, stable equipment with greater control and when the user slides on slopes at high speeds, the risk of serious injury is reduced.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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Prof. Cano Recognition. Skateboard for slope sliding. 45th International Exhibition of Inventions, Geneva, Switzerland - Silver Medal.