

AUTOMATED INERTIAL FEEDBACK FOR HALF-PIPE SNOWBOARD COMPETITION AND THE COMMUNITY PERCEPTION

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Abstract No scientific research has yet targeted the athletic performance aspects or subjective judging protocols associated with elite half-pipe snowboard competition. Recently however, sport scientists from the Australian Institute of Sport (AIS) initiated a video based analysis of key performance variables (KPVs) associated with elite half-pipe snowboard competition. The development of a preliminary automated feedback system based upon Micro-electrochemical Systems (MEMS) sensors such as tri-axial accelerometers and tri-axial rate gyroscopes, designed to calculate objective information on these sport specific KPVs was initiated in parallel. Although preliminary, the results may provide practical benefit for elite half-pipe snowboard training and current subjective judging protocols. In light of theorised implications, this paper investigated the perception and possible social impact of these concepts on the practice community. Data was collected via semi-structured, open ended interviews with nine subjects (six athletes, two coaches, and one judge) currently involved in elite half-pipe snowboard competition. This study revealed 6 dimensions and 20 sub-dimensions relating to the practice community's perceptions of 3 major themes that emerged during interviews. The themes included: 1) State of the current subjective judging system, 2) Automated feedback and objective judging system, and 3) Future direction of the sport. There was dominant negative perception of a proposed automated judging concept based solely on objective information unless the system integrates with the current subjective judging protocol and continues to allow athletic freedom of expression and the capacity for athletes to showcase individual style and flair in elite competition. The results of this study provide the practice community an initial public forum to describe its perceptions to future automated judging concepts, nominating them to be the primary determinants of change, technological or otherwise, within their sporting discipline.

1.0. Introduction

Key Performance Variables (KPVs). Unlike more traditional sports such as swimming, running, and cycling, very little is known about the characteristics of half-pipe snowboarding's elite athletes or the physiological and kinematical demands of competition. Sport scientists from the Australian Institute of Sport (AIS) have recently undertaken a preliminary video based analysis of the effect sport specific key performance variables (KPVs) such as total air-time (TAT) and average degree of rotation (ADR), have on scores during elite half-pipe snowboard competition. This analysis has shown that when TAT and ADR are combined (multiple linear regression), they show a strong correlation with an athlete's subjectively judged score ($r = 0.70$), and

subsequently account for approximately 50% of the shared variance associated with the overall score ($r^2 = 0.49$, $SEE = 4.04$) during Fédération Internationale de Ski (FIS) Half-Pipe Snowboard Competition Finals ($n = 2$) in Bardonecchia Italy, February 2005 (Harding *et al.*, 2005; Harding *et al.*, 2006).

Automated KPV Feedback System. The dilemma with video based analysis of sport specific KPVs is the labour intensive nature of calculation and the associated time-delay in information feedback. AIS sport scientists have therefore recently developed a method of calculating KPV information using Micro-electrochemical systems (MEMS) based tri-axial accelerometers (ADXL_{XXX} series, Analogue Devices) and tri-axial rate gyroscopes (ADRXS300 gyros, Analogue Devices). It is now possible to calculate air-time during half-pipe snowboarding using 100Hz tri-axial accelerometer data and mathematical pattern recognition algorithms. This preliminary method shows a strong correlation ($r = 0.95$) with a reference standard for air-time calculation (video analysis) and accounts for 90% ($r^2 = 0.90$, $SEE = 0.05s$, $Mean\ Bias = 0.01s$) of variation inherent in the air-times calculated by the reference standard. Reliability however is questionable, only correctly detecting and calculating accurate air-time for 73% (118 out of 161 aerial acrobatic manoeuvres) performed by elite half-pipe snowboard athletes during this study (Harding *et al.*, 2005; Harding, 2006; Harding *et al.*, 2006).

Proposed Automated Judging. Half-pipe snowboard competition is judged purely subjectively and recent opinion has called for a system of judging to be introduced that is based upon more accurate, reliable and stringent measures, without stifling athletic freedom of expression. Whilst AIS research presents a preliminary analysis on the effect of KPVs on athlete's scores, it also suggests that accurate and reliable quantification of these sport specific variables may prove beneficial in enhancing subjective judging protocols currently used in elite half-pipe snowboard competition. This paper proposes that a MEMS based feedback system could assist judges by providing accurate, electronic 'memory boards' (a record of an athlete's run characteristics currently written by hand) by quantifying and displaying objective information on sport specific KPVs such as TAT and ADR (information currently unavailable to elite-level judges). This will enable judges to focus solely on the execution and overall composition of aerial acrobatics incorporated into a competition run.

Social Impact of Technology. The proposed introduction of a competition judging system based solely or partially upon objective information into half-pipe snowboarding (a sport habitually focused on athletic individuality and freedom of expression) will no doubt provide sport scientists (as implementers) and the practice community (those affected) with challenges. Perhaps the most significant aspect of change in sport is that any such action can dictate the future of a sport in a way that makes reversing such changes very difficult (Miah, 2000). Technology often has unintended consequences, effecting change beyond its original purpose (Tenner, 1996; Miah, 2000). As argued by

Miah (2000), changes, technological or otherwise, should be preceded with some discussion about what future is sought for a specific sport and thus, where limits might be drawn on the changes. Defining who should determine the nature of a sport ought not to be a difficult issue. It seems imperative to ensure practicing communities are allowed to articulate their interests in forums that convey influence (Morgan, 1994). This paper is a result of action based research involving a progressive partnership ideology with the practice community. It has allowed the snowboarding community a forum to describe its perceptions on the impact of future automated judging concepts and possible technological change within their sporting discipline.

1.1. Methods

Population and Sampling. The population for this study was selected by theoretical sampling and included nine subjects (six elite athletes, two national coaches, and one elite competition judge). Subjects' level of experience in elite half-pipe snowboard competition ranged from 4 – 12 years.

Data Collection. The results of this study were obtained by interviewing subjects on their perceptions of how technological change would impact on the culture of their sport. The nature of the research questions directed the data collection process be in-depth and consistent with an inductive analysis (Smith & Shilbury, 2004). In-depth interviews were selected as the most suitable data collection tool. Subjects were interviewed between 16th and 20th October 2006 at the AIS. Interviews were semi-structured, involved posed, open ended questions, were recorded on video, and later transcribed word-for-word. Each subject was interviewed individually for 20-45 minutes. All subjects approached for this interview accepted.

Data Analysis. Interview transcripts were first examined to gain general familiarity. Dominant themes were noted and these formed categories. These categories became the codes by which transcripts were further interpreted. Manual coding was undertaken with a hierarchical three stage process (Strauss & Corbin, 1990) beginning with identification of 'open' codes. Open codes provided a broad set of cultural categories with which to conduct subsequent reduction. 'Axial' coding subsequently divided each open code into several axial codes which reflected cultural dimensions employed to measure the perception of the practice community to specific issues. Axial codes were then divided into 'selective' codes. Selective codes provided researchers capacity to highlight the content of specific cultural dimensions (Smith & Shilbury, 2004). Labels were selected that best described conceptual contents of each code however; it is worth noting that labels represent researcher interpretation of content (Smith & Shilbury, 2004). The number of occasions selective codes were mentioned revealed the significance of each sub-dimension to major cultural themes. A reliability measure used by Smith & Shilbury (2004) was adopted by this study. Where Smith and Shilbury calculated an *inter-*

researcher reliability score, this study used one researcher undertaking a test-retest analysis on each interview one week apart hence; an *intra-researcher* reliability score was calculated. This study generated a satisfactory *intra-researcher* reliability level greater than 90%, as recommended by Miles & Huberman (1994).

Theoretical Sampling Limitations, Informed Consent and Ethical Approval. As all subjects were of Australian nationality, this was accepted as a limitation. Future studies would benefit by increasing sample size and evaluating international practice community members. Subjects read ‘information to participant’ and signed ‘informed consent’ forms prior to taking part. Experimental procedures were approved by the Ethics Committee of the Australian Institute of Sport on 17th August 2006 (approval number 20060807).

1.2. Results

This paper investigated the snowboard practice community’s perception to recent technological research. Table 1 shows the six axial codes (dimensions) and twenty selective codes (sub-dimensions) related to three major themes (open codes) that emerged during the interview process. The major themes were: 1) The State of the Current Subjective Judging System, 2) Automated Feedback and Objective Judging System, and 3) Future Direction of the Sport.

Table 1. Cultural Dimensions (Axial and Selective Codes)

Strengths of the Current Subjective Judging System

1. Subjective perception of style and overall run execution
2. Allows athletic freedom of expression
3. Well trained judges with experience in the sport
4. Improvement on the gymnastics model of judging
5. Multinational judging panel

Weaknesses of the Current Subjective Judging System

1. Subjective perception of style and overall run execution
2. Expansive criteria displayed as one measurement – termed ‘Overall Impression’
3. Memory board short hand time constraints during judging
4. Limited access to experienced and high level judges
5. Increased population of athletes reaching ‘optimal performance’
6. Subjective judging error in aerial amplitude perception

Replace Subjective Judging with Automated Objective Judging

1. Removal of subjective perception of style and overall run execution
2. Removal of athletic freedom of expression
3. Generation of incorrect results
4. Separation from what is valued in the sport

Integration of Both Subjective and Objective Methods in Judging Protocols

1. Accurate KPV information perceived as beneficial
2. Objective information beneficial as judging aid (automatic memory board)

Possible Cultural Perception of Automated Judging

1. Positive if integrated with current subjective system
2. Negative if used as the only measure of performance

The Consensus on Future Direction of the Sport

1. Freedom of expression and athletic individuality culminating in well executed and stylish performances

1.3. Discussion

Of the six axial codes the most prominent was, “weaknesses of the current subjective judging system”. The most prevalent sub-dimension related to this axial code was labeled, “subjective perception of style and overall run execution”. The inability of the current subjective judging system to consistently identify correct competition results was a strong perception of the practice community, mentioned by eight out of nine subjects:

...it's subjective, it's personal opinion. You might think it [a run] looks good, I might think it doesn't, and that at the moment is the weakness because that's the difference between who wins and who doesn't win sometimes. It's not the fairest way...

The axial code labeled “strengths of the current subjective judging system” was however, the second most prominent dimension. Paradoxically, the most prevalent sub-dimension associated with this axial code was also labeled, “subjective perception of style and overall run execution”. All subjects mentioned this strength. The second most prevalent perception related with strengths of the current judging system was that it, “allows athletic freedom of expression”:

...it let's the riders show who they are and what they can do freely. They can basically show their personal being in their style and who they are as a snowboarder. You can go at it, you can invent new tricks, and you can invent new grabs, go big, go small, and spin as fast you want. The system currently lets you do that...

That fact that paradoxically, the same sub-dimension is considered both a judging strength and a weakness offers insight into half-pipe snowboardings' underlying cultural ethos. All subjects revealed aspects of the sport they valued without posed questioning from researchers. The information emerged into a major theme labeled, “Future direction of the sport”. Snowboard competition seems focused on “freedom of expression and athletic individuality culminating in well executed and stylish performances”:

...it's a free sport driven by free people...

Snowboarding culture appears athlete focused and judging protocols have taken into account criteria that athletes value. However as performance levels increase, judging criteria may have to adapt. Miah (2000) evokes sport's overall self-annihilating teleology; that increased numbers of athletes ultimately achieve ‘optimal performance’, thereby outgrowing the structure of the game. Sports are then forced to adopt altered performance assessment, equipment changes, or altered game rulings to again separate similarly capable athletes. Two subjects revealed this concept without posed questioning:

...the weakness now is that the sport has progressed at such a rapid rate, the majority of riders are doing the same tricks...up until 2006 it [subjective judging] worked because the level of the sport hasn't got to a level where it's an issue yet. Looking forward it is going

to be an issue. It's going to be hard to judge overall impression in the next Winter Olympics, and then it is going to be even harder another 10 years down the track...

This paper has proposed that automated feedback calculating objective information on half-pipe snowboarding KPVs could benefit subjective judging protocols, and perhaps prolong the sports' possible self-annihilation (Harding, 2006; Harding *et al.*, 2006; Miah, 2000). The notion this system could judge half-pipe competition automatically, without input from subjective judges was however, vigorously opposed by all subjects:

...I think there's no way it could take over the judging, style and execution is such a big part of the sport.....I think that would spoil snowboarding...

Judging based purely on objective information opposes what is valued, removing the two prevailing judging strengths and regimenting the competition. However, integration of objective feedback with subjective protocols was perceived positively by all subjects. The integration of technological advances without the removal of opportunities for athletic freedom of expression will maintain what the practice community values.

1.4. Conclusion

This is the challenge for elite half-pipe snowboarding competition in the future. While technological advancements are theorised to enhance athletic performance and judging protocols, it needs to be balanced with the culture of the sport so that athletes continue to see themselves as snowboarders with the freedom and individuality that entails. This study demonstrated there needs to be a balance between scientific advancement and practice community expectations:

...we do not want to be ballerinas; we want to be snowboarders...

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