SPORTS TECHNOLOGY

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Ski faster or win rugby: art, science or technology?

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Do the improvements in sports science and technology take the enjoyment and artistic skill of the athlete out of a sporting performance? Are we spoiling the spirit of sport by reducing the magic of a performance to a series of mathematical equations? As a New Zealander and supporter of the New Zealand All Blacks rugby team, which failed to reach the semi-finals of the recent Rugby World Cup, I have to answer 'No'. The All Blacks were believed to be the best team in the tournament. The players were conditioned, according to the best scientific principals, to peak for the final games of the tournament. But, to my sorrow, the well-conditioned All Blacks were closely beaten by a fired-up and flamboyant French team. Perhaps the All Black rugby team could apply a 'dynamic systems approach' to pre-World Cup training?

A recent trend in sports performance analysis is the dynamic systems approach. A keynote paper on this topic was presented by Wolfgang Schöllhorn at the recent International Society of Biomechanics in Sport (ISBS) conference in Brazil [1]. My interpretation of the new approach is that in addition to the sports scientist trying to measure and describe, or the coach trying to prescribe, the 'ideal movement set' to the athlete, the athlete is made to explore his or her own unique solution to the problem. This can be achieved by the coach supplementing instructions with a carefully designed variable training playground. The dynamic systems approach suggests that instead of careful 'scientific' conditioning, the All Blacks needed to be highly stressed before the World Cup. This stress might have been applied through the optimum selection of difficult opponents and varied playing conditions, even if these were artificially imposed on the team.

In ski racing, the dynamic systems approach gives the athlete more room for artistic expression. It suggests that artistic expression can work hand-in-hand with new advances in sports science and technology. The theory is that by increasing the variation and conditions under which an athlete can perform a task, both the athlete's maximum performance and ability to produce the desired outcome will improve consistently.

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The idea of increasing variability in training has existed for more than 2000 years. Tai Chi masters often perform a sequence of the same combat actions at different speeds to increase variability, or they train blindfolded to challenge their proprioceptive systems.

Ingemar Stenmark, historically one of the most successful ski athletes, is reported to have incorporated variability into his training by balancing on a slack rope. With the recent developments in sports technology, it should be possible to devise even more effective training aids and protocols that can transfer greater gains to the target sports.

Several devices have been developed to increase variability in training. Most of us will have come across the 'Swiss ball' or the 'wobble board', which may help to increase the transfer of strength gained from resistance training sessions to applications in the field. At the 2007 International Congress on Science in Skiing in Austria (ICSS) the three new devices to increase variability in alpine ski race training were displayed. The first was an attachment to the binding that made the boot pivot about the boot centre so that both extreme 'weight forward' and 'weight backward' stances could be trained. It also placed more stress on the athlete's postural balance system if the athlete was instructed to balance the pivoted boot parallel with the ski surface. The second was an elastic band connected from a harness to various positions on the athlete's leg, boot or ski that forced the athlete to activate different muscles to ski. The third was a parallel ski device that forced the athlete to keep both skis parallel.

What is the optimum level of variability in training and performance? When should external instruction be rigidly prescribed, and when is it detrimental? The answers to these questions may be extended beyond the elite sporting domain and into any situation where people need to learn new tasks, for example, in schools. Every performance by an athlete is unique, but there must be some key aspects that are present in all successful performances. What are these key aspects?

In the case of skiing, technology will help us answer these questions. Advances in computing power and the equipment we use to measure athlete performance now allow us to measure hundreds, if not thousands of ski turns in a single day. Determining the key aspects and optimum variability in performances will involve a holistic analysis. Data will need to be fused from many different measurements of the athlete, the skis and the course conditions. To compare thousands of turns

and still present the data before the athlete's retirement will require specifically designed computer algorithms.

In summary, art, science and technology used in innovative ways are required to produce the elite athletes of tomorrow. Journals like *Sports Technology*, which embrace innovation in the multidisciplinary area of sports, science and engineering, will be useful aids in producing faster, safer and more artistic athletes. The recent dynamic systems approach can accommodate individual movement patterns or artistic expression into contemporary biomechanical analysis. Ski athletes need not be worried, their jobs are safe. A presentation of a ski robot made at the ICSS highlights that there is a still a lot to learn about an artistic performance. The ski robot, although ingenious, failed to pass through the second gate in the dry land trial. The authors of the conference paper commented that 'It wasn't bad for a two-year-old child' [2].

Matthew Brodie is the winner of the 2004 New Zealand Speed Skiing Championship (Production Class). Born in 1975, he obtained a Bachelor of Engineering (Honours) from the University of Canterbury, New Zealand in 1997. After several years as a competitive skier, Matthew turned his attention to research and is currently completing a PhD in the optimisation of athlete movement in alpine ski racing at Massey University, New Zealand. Mathew is the recipient of the 4th International Congress on Science and Skiing 2007 Innovation Award, and the 2005 Emerging Scientist Award, presented at the Sport and Exercise Science New Zealand Conference.

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