SEAMLESS SEQUENTIAL INTEGRATION AS A COMPREHENSIVE MEANS OF ADVANCED ATHLETE PREPARATION: A CASE STUDY

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INTRODUCTION: For over a decade, sport science statisticians such as Dr. Will Hopkins have been leading a paradigm shift in how meaningful changes are defined and measured within high level sport (Hopkins, Hawley, & Burke, 1999). In response to this, Dr. John Kearney called on practitioners to engage in critical reflection of their training methods and how the summation of its parts impacts the athlete's ability to perform (DeWeese, Hornsby, Stone, & Stone, 2015a; Kearney, 1999). Through such reflection, coaches and sport scientists alike must seek an optimal method of sequencing and integrating methods of performance enhancement to develop skill and physical readiness simultaneously.

Seamless Sequential Integration (SSI) is a planning tactic utilizing pedagogy and procedural memory development to combine effective aspects of training methods, such as conjugate sequential (CS), vertical integration (VI), and short-to-long (S2L). This approach emphasizes the motor development and skill mastery needed for high level performance (DeWeese, Sams, & Serrano, 2014; DeWeese et al., 2015c; Duchateau, Semmler, & Enoka, 2006; Francis, 2008; Sale, 1988, Verkhoshansky, 1978 as cited in Siff & Verkhoshansky, 1998). Through proper progression and structure of these tenets (CS, VI, and S2L), the maturation of specific physical and skill-based qualities are advanced in lock step. SSI has been most notably utilized in the preparation of elite level bobsled, canoe/kayak, and luge athletes, leading to podium appearances on numerous stages, including multiple Olympic and World Championship medals (DeWeese et al., 2014, DeWeese, 2016).

Bobsled, like many sports, integrates a qualification period within the off-season. Using team camps and combines, the national governing body gains insight to potential make-up of the national team for the impending competitive season. A method that retains fitness while enhancing preparedness through skill and physical development in a complimentary manner is warranted, which SSI provides through the cooperation of CS, VI, and S2L. Initially, S2L emphasizes shorter sprint distances followed by advancement to longer sprint distances as the athlete develops skill through sequenced acquisition of sprint components (Rumpf et al., 2016, Gerrig, 2013). In doing so, S2L utilizes the part-to-whole approach to seamlessly blend core concepts of the sprint (DeWeese et al., 2014; DeWeese et al., 2015c; Gerrig, 2013). Similarly, CS utilizes blocks of concentrated loads to develop specific fitness characteristics in a phasic, progressive manner (Siff & Verkhoshansky 1998). In doing so, previously trained physical characteristics support expression of more advanced motor abilities, while previously trained characteristics are revisited via retaining loads (Issurin, 2008; Siff & Verkhoshansky, 1998; Verkhoshansky & Verkhoshansky, 2011). VI supports both CS and S2L by allowing a means of emphasis and de-emphasis of training elements, thwarting potential involution (DeWeese, Hornsby, Stone, & Stone, 2015b; Häkkinen et al., 2000). Therefore, VI is the thread that stiches together the physical development of CS and the skill development of S2L, allowing SSI to be both comprehensive and adaptive.

The degree of success of such an integration, then, requires a summative evaluation that closely resembles the skill development and physical qualities necessary for a given sport. Direct evaluation in competition is a logical choice, but may not provide the control necessary to

properly evaluate the relative contribution of training methods. Therefore, the most practical way of evaluating the impact of training on this class of individual may be through non-traditional means. Combines allow the most controlled and standardized method for repeated measures by which the efficacy of training modalities can be measured. Therefore, the purpose of this study is to examine the effectiveness of SSI curriculum on bobsled combine preparation.

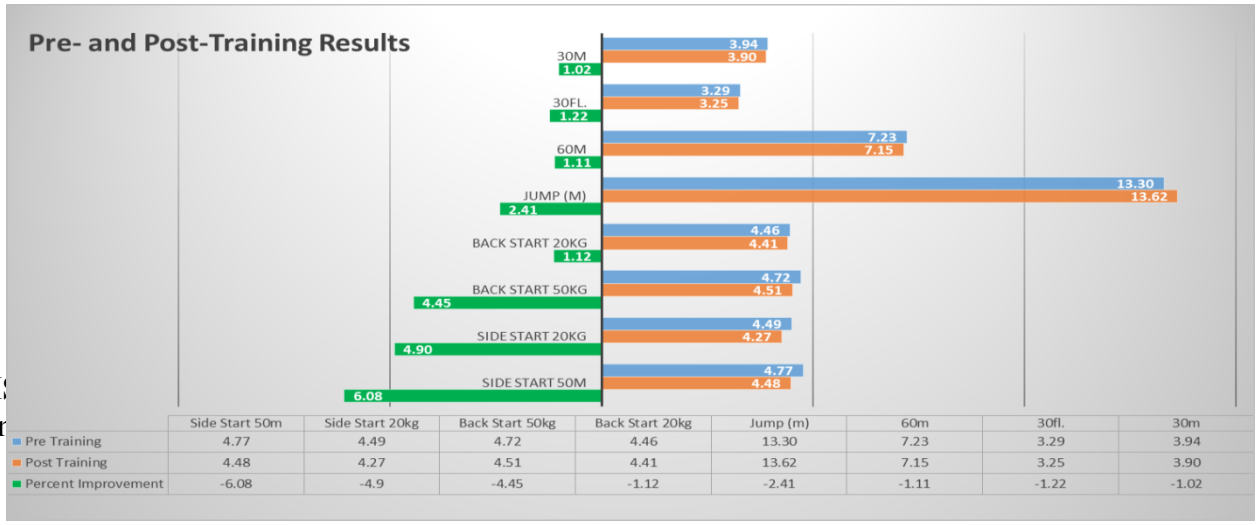
METHODS: To explore SSI within an applied setting, a high-level bobsled athlete performed speed development and resistance training. Speed development was typically performed in the mornings with resistance training performed in the afternoons three days per week. Training followed a polarized training model in which days of high central nervous system (CNS) demand, such as strength, power, and speed development, were augmented with at least one subsequent day of active or passive recovery.

Within this general weekly format, the athlete participated in 21-weeks of training consisting of six distinct blocks. The training was constructed using SSI methodology. During the final three blocks of training, a functional overreach was implemented in the first week of each block for the athlete to maintain previously developed fitness characteristics.

Team Great Britain's bobsled-specific evaluation, fulfilling the requirements for national team consideration, is the Swiss Test. The Swiss Test is comprised of three events, with eight scoring measures disseminated across them to evaluate an athlete's performance capabilities related to bobsled. The Swiss test protocol includes a sprint, pushing a roll bob (a light weight, 42kg bobsled frame on wheels that accommodates additional loading), and a plyometric test (British Bobsleigh & Skeleton, n.d.).

Sprint (Best of 2 Trials)	Roll Bob (10-40m)	Plyometric Test (best of 5 trials)
0-30m	Back Start – 20kg	5-repeating bounds
30-60m	Back Start – 45kg	
0-60m	Side Start – 20kg	
	Side Start – 45kg	

RESULTS: The athlete improved in each measure assessed by the Swiss test with specific measures and percent improvements displayed in Figure 1.



	Side Start 50m	Side Start 20kg	Back Start 50kg	Back Start 20kg	Jump (m)	60m	30fl.	30m
Pre Training	4.77	4.49	4.72	4.46	13.30	7.23	3.29	3.94
Post Training	4.48	4.27	4.51	4.41	13.62	7.15	3.25	3.90
Percent Improvement	-6.08	-4.9	-4.45	-1.12	-2.41	-1.11	-1.22	-1.02

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Figure 1. Pre- and post-Swiss Test scores with percent change values.

each combine event including jump, open sprint, and bobsled-specific evaluations. However, it is worth noting that the approach to the athlete's preparation was a motor and skill based phasic development towards bobsled performance. The combine provided an opportunity to express skill characteristics developed to that point. Due to the intermittent nature of evaluation, training remained focused on preparation for the season, with only a modest reduction in volume load to accommodate the physical and other external stressors of performing the Swiss Test (DeWeese et al., 2015a). These factors should be considered when interpreting the magnitude of change observed in the study.

The Swiss Test protocol includes open sprinting, pushing a roll bob, and plyometrics. The initial event is open sprinting, primarily confined to distances associated with the acceleration and transition phases of maximal velocity sprinting. Due to the brevity of distance in the open sprinting measures, the athlete's ability to maintain acceleration inherently provides them an advantage (DeWeese et al., 2015c; Ross et al., 2001). S2L speed development, which emphasizes acceleration abilities, combined with strength development, may have provided the repetitions and force expression necessary to refine the qualities needed for the Swiss Test open sprint event (DeWeese et al., 2015c; Francis, 2008; Weyand et al., 2000). Beyond open sprint abilities, the curriculum progressed to include weighted sled pushing. Based on substantial combine improvements in roll bob measures, the relative mastery displayed by the athlete may have been attributed to the terminal training progression (DeWeese et al., 2015a; Verkhoshansky & Verkhoshansky, 2011). Contrary to the skill-intensive nature of the open sprint and roll bob events, the success in the plyometric tests are underpinned by magnitude and rate of force production capabilities of the athlete (Stone, Stone, & Sands, 2007). Like skill intensive events, however, physical qualities must be developed in a sequential manner to fully realize expression of specific motor abilities necessary for success in the bounding event (Hori, Newton, Andrews 2008; DeWeese et al., 2015a, Weyand et al., 2000).

The athlete, despite the Swiss Test occurring in the mid-preseason, demonstrated a high level of athleticism, physical readiness, and skill proficiency. SSI, through the tenet of VI, can manage training interruptions. VI allows for a de-emphasis of specific qualities or skills without a drop-off in performance (Francis, 2008). Using retaining loads and shifting emphases, training maintains its focus towards competitive season performance despite intermittent stressors (DeWeese et al., 2015b; Häkkinen et al., 2000, Verkhoshansky & Verkhoshansky, 2011). The results of the present study indicate that the athlete was managed effectively, recording the second highest Swiss Test score for a Great Britain female bobsled athlete. Through the historical ranking of this outcome and the substantial improvements from an individual standpoint, the efficacy of SSI is supported as an integrated means of sequencing effective preparation for combine performance despite not specifically preparing for such an event. SSI demonstrated comprehensive preparedness, and resulted in success within Kearney's (1999) parameters of summative and integrated evaluation. Future research should examine SSI as a means of preparation for other athletic evaluations and competitions.

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