THE TECHNICAL ECONOMY INDEX:

A tool for cyclic sports

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In aquatic sports such as swimming, kayaking and rowing, a high degree of technical proficiency is necessary to develop the speed demanded for competitive success. The Technical Economy Index (TEI) is a quick and simple measure which enables a coaches of a variety of competitive sports to monitor both technical development and economy of motion during execution of a race plan. This article discusses the application of the TEI to swimming, rowing and kayaking, but it is also possible to apply it to other cyclic sports where technique is an important feature of the movement patterns.

What is the TEI?

Previous research into measures of technical economy for competitive swimmers produced at least two indicators: the Stoke Index (SI)[1,6] and the Arm Stroke Index (ASI)[4,5]. These indicators have been shown to be related to the energy cost of swimming, to stroke proficiency, and to be highly reproducible.

The Technical Economy Index (**TEI = velocity[v] x distance per stroke[dps] x 10**) is a variant of these two indices, increasing as proficiency improves. The TEI began as an attempt to examine the SI of Costill et al. (1985)[1] in a kayaking context and its ability to discriminate placegetters in the 1992 Barcelona Olympic K1-1000m final event from video footage.

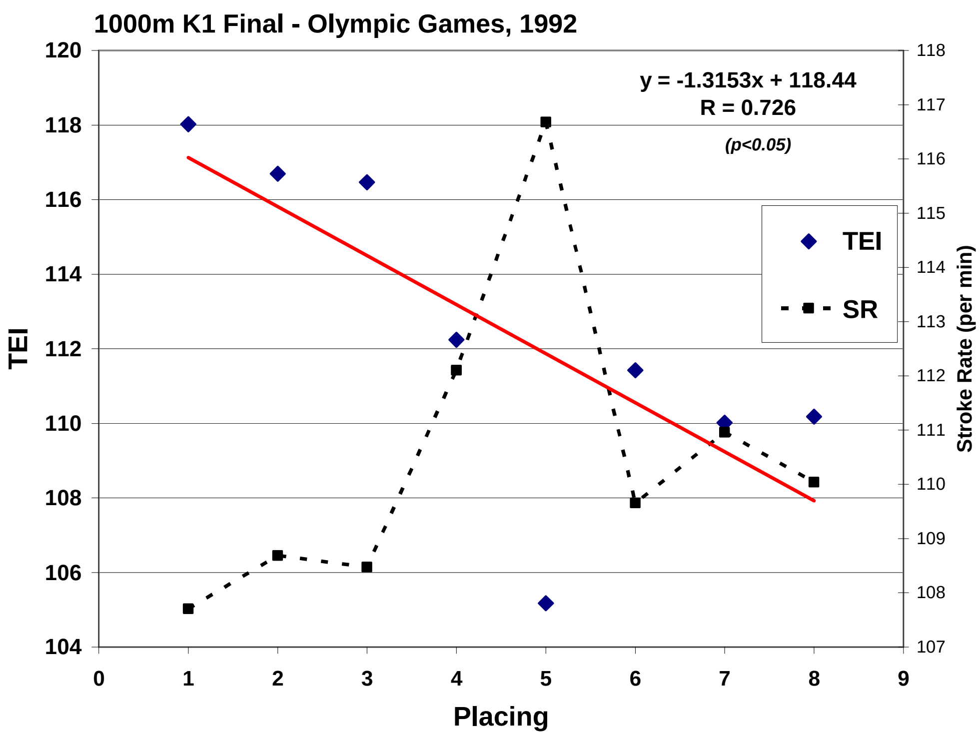

Figure 1. Data plots of placings during the K1-1000m final at the 1992 Barcelona Olympic Games showing TEI and SR values)

Figure 1 above demonstrates a significant correlation between average TEI and placings in this event, and illustrates that the higher placed paddlers recorded the higher TEI scores. This diagram also presents the average Stroke Rate (SR) for each competitor.

A similar exercise was undertaken with swimming, and data from the 2004 US Olympic trials[7] yielded a mixed, though encouraging, outcome given the homogenous nature of the finalists. The evaluation demonstrated a significant relationship between TEI and placing in male Freestyle events. Strength, height and limb length differences between males and females are likely to be a factor in the lack of significance for female results, as these characteristics have a large influence on the determination of propulsive forces and dps. However, these factors do not account for the lack of significance in four of the six form stroke events for males, and this warrants further investigation.

From the foregoing, it can be presumed that TEI does provide a snapshot of technical proficiency or economy of freestyle swimming for males, because the swimmer with the highest TEI exhibits superiority in swim velocity and dps.

Further support for the use of TEI is provided from data in a previous study (Hooper et al. 1998)[2] where TEI was calculated from 100m and 400m maximal effort freestyle swims, but not reported. In this study, athletes were also required to perform a maximal effort swim (freestyle) while tethered. Data collected enabled calculation of the total work performed for the one-minute duration of the test. Male data demonstrated a significant relationship between TEI and total work, but again, the data from females were not significant, and it is suggested that the lower capacity for force production in females due to strength deficits could account this finding.

Practical uses of the TEI

The TEI can discriminate male freestyle swimmers on the basis of stroke proficiency. It can also be used for a particular swimmer to assess race plans in events where technique execution is a major component of a competitive outcome. Part of the requirement of learning good technique will be to experiment with different SRs and their effects on velocity, dps and stroke economy, and the TEI is suggested as a tool to monitor these technical characteristics.

The simplicity of the TEI enables the coach on pool-deck to monitor the skill acquisition process, not only during training session, but also during competitive events. The graphs In Figure 2 below present an analysis of the men's 400m freestyle final at the 2004 US Olympic Trials[7] to demonstrate the value of TEI and a method for its application. Figure 2d demonstrates that, from a technical perspective, Place 3 swimmer lost form at the 100m mark and continued for the remainder of the race. The TEI showed the technical shortfall before the other three plots did so with conviction, and showing divergence at the 100m mark and yet another at the 200m mark.

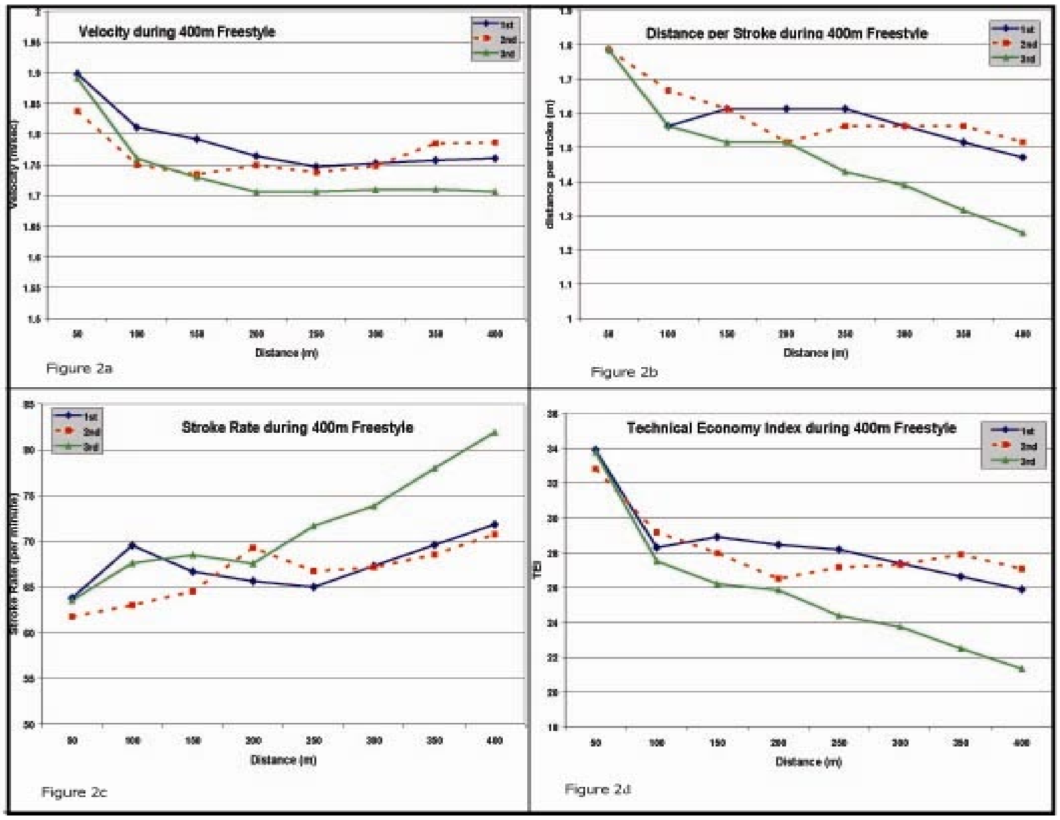

Figure 2. Data plots of velocity (2a). distance per stroke (2b), Stroke Rate (2c) and TEI (2d) for first 3 placings in 400m freestyle final at 2004 US Olympic Trials

An analysis similar to that illustrated in Figure 2 above was performed on several events at the 2004 Athens Olympic Games rowing events[3]. Data for the Men's Coxless Pairs are presented in Figure 3, demonstrating the ability of the TEI to identify technical superiority of the winning crew.

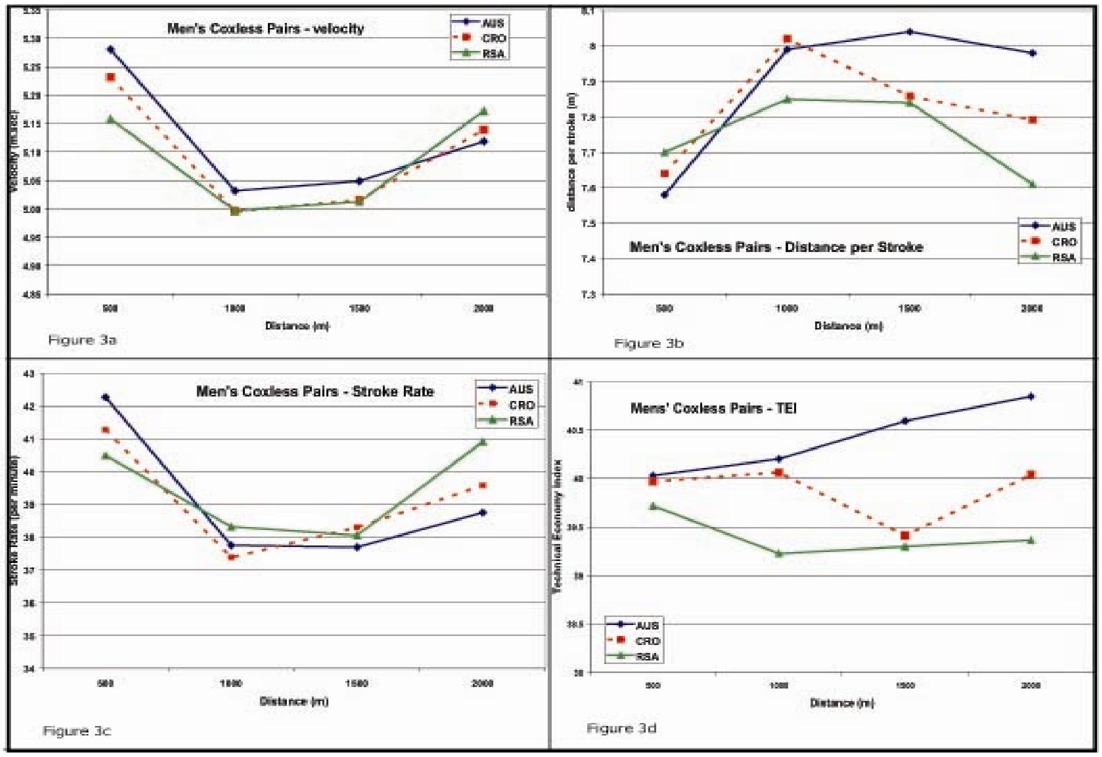

Figure 3. Data plots of velocity (3a). distance per stroke (3b), Stroke Rate (3c) and TEI (3d) for first 3 placings in Men's Coxless Pairs at 2004 Athens Olympic Games rowing regatta

The TEI can point to inefficiencies in the execution of the race plan such as the increase in Stroke Rate by the third placed swimmer in Figure 2. Alternatively, the superior dps displayed by the winning Coxless pairs in Figure 3 demonstrate a high level of technical proficiency. The TEI offers an opportunity to monitor the blend of biomechanical and physiological factors important in developing a winning competitive strategy and to assist in the detection of technical problems.

Another way of using for the TEI is in the development of an athlete. If a coach has TEI values for elite athletes, they can provide benchmarks to young athletes and targets for them to aspire to in their technical development. For example, Table 1 illustrates the average TEI values for the 100 and 400m swimmers in the finals of the 2004 Olympic Trials[7] compared with the values for the (Taper) study referred to above[2] with younger swimmers. The difference between the two groups indicates a development gap which the coach can address during technical training sessions.

Table 1. Comparison of Freestyle TEI values for elite US swimmers (first 3 placings) and mean values for well-performed State-level swimmers (males: n=14; females n=11)

Subjects	Distance	Males	Females
2004 US Olympic Trials	100m	30.6	22.4
Taper Study	100m	22.1	17.0
2004 US Olympic Trials	400m	27.4	18.3
Taper Study	400m	17.4	16.2

The TEI is quick and simple to calculate and can serve a number of functions in the technical development of an athlete, from junior to elite levels. It is not meant to replace the sophistication of biomechanical testing, but to provide a field test that can be used with confidence by a coach of athletes at any level. As can be seen from the research described above, this tool can be applied in a range ofl sports where technique is an important component of competitive success.

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