Higher Speed Double-Push Tracks For Chad Hedrick

c. P. J. Baum, March 2000.

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Introduction

While working on the "Fully-Efficient Skating Stroke" I introduced the *video Time-Track* which shows the skater's foot pattern in a manner similar to the older Ground Track. This technique was used first on a video clip of Chad Hedrick supplied by Kim Hendrikse and then on a video clip of Barry Publow which is available for free download on Barry Publow's website. Here I am examining a video clip of Chad Hedrick which provides video time tracks at a higher speed than the first set of video tracks. The tracks below were made from another video clip provided by Kim Hendrikse. This time Kim took the video himself from a truck leading Chad who skates down the road. As Kim owns this video he has kindly made it available for viewing on the internet on this site. The video is approximately 7 Mb long in Mpeg format. It can be downloaded and viewed with a recent version of Microsoft Media Player or an Mpeg player.

Here are two examples of time tracks formed from the video mentioned above. They cover several cycles of Chad Hedrick's double push. As with the multicycle tracks of Barry Publow (on an earlier page) they show considerable variation from cycle-to-cycle.

Discussion And Conclusions

Two Ways To View The Tracks

Because the tracks just presented intersect one another they can be viewed in two different ways: (1) as a continuous track from the right skate and a continuous track from the left skate or (2) as an inner track and an outer track both centered on the skater's center line. Viewed in the second fashion there is a wide track which is formed by the left skate for half a cycle and formed by the right skate for the next half cycle and also there is a narrow track formed by the right then left skates in alternating half-cycles. I find this second method more useful here because the wide outer track is nearly sinusoidal like the stroke I called the Fully Efficient Stroke. However, this track is now formed by both skates in sequential fashion rather than by a single skate. This wide sinusoidal track would be the path where most of the power is being delivered. The narrow inner track is often not sinusoidal and sometimes the inner skate appears to glide nearly straight forward.

Background For Understanding The Tracks

Before Chad, skating consisted of the "classic" stroke where power was delivered by opposite skates sequentially as one leg pushed and the other provided support for a glide. Then came the "double-push". My concept of the pure double-push was illustrated in a previous set of

video tracks taken of Chad where he was using both legs to produce power simultaneously. This was the case where both skates produced a pair of 'parallel' sinusoidal tracks. So these two cases seem to form the extreme skating styles available ranging from the classic single-push to the pure double-push. Now it seems to me that the tracks on this page really represent neither pure single-push nor pure double-push but rather something between classic and double-push. In fact, it looks like there is a whole range or continuum of skating styles between the two extremes corresponding to a whole range of power output.

I spent considerable time studying the nonlinear stroke resulting in the identification of the importance of the cornering force and its inclusion into a fully efficient stroke model. However, this work looked at only a single skate track. On an earlier video (taken at lower speed) Chad's left and right skates were forming quite similar motions resulting in similar left and right tracks. So there the (instantaneous and time-averaged) power generation was evenly divided between left and right legs. On the tracks on this page the outer skate dominates the power generation. So it is apparent that the instantaneous power is now split unevenly between left and right skates. The time-averaged power is still nearly equal between left and right as one leg powers then the other on alternate half-cycles. In this respect Chad's stroke method here is similar to the classic single-push.

Concluding Remarks

It is apparent from the narrowness of the inner track shown above that the inner skate is not developing full power - and on some cycles appears to simply glide forward. But, pardoxically, here he is moving faster than in the earlier clip where he was using a pure double-push which should produce higher power in my view. Tentatively I would resolve the paradox in this way:

- **The pure double-push can produce higher power and therefore higher acceleration.**
- **Here Chad is not accelerating. He is maintaining his speed against wind and wheel drag.**
- **If he were to accelerate for very long at this speed his power level might reach his maximum and could limit the time duration for which he could maintain this speed.**
- **This suggests that he has purposely down-regulated his power output to maintain his speed for a long duration.**

However, he could have chosen to produce the same power output level using a pure double-push of narrower stroke width. Why didn't he do this? I suggest the following:

- **If you look at Kim's original video you see that Chad lifts the outer skate off the ground and returns it past the center line behind the**

"gliding" skate. It seems that this accomplishes three objectives:
    - It introduces a time lag as one skate moves behind the other. This lowers the stroke frequency.
    - It widens the stroke width as the skate sets down one exactly behind the other rather than one next to another. This gives a few inches more stroke width. This wider stroke width counters the lower power from the lower stroke rate.
    - As the recovery skate moves behind the "gliding" skate its sideways motion needs to be reversed for the next stroke. Applying the force to stop the recovery skate (which is lifted well off the ground) generates a torque which acts through his body and ends up acting on the "gliding" skate which is on the ground. This torque turns the skate more forward increasing his efficiency through the cornering force developed from the turn.
- Consequently it looks to me like Chad has chosen to move from pure double-push back closer to single-push because it allows him to produce the equivalent power he could have produced with a pure-double-push but this way he can power-skate with long-width low-frequency strokes which allow one leg to largely rest while the other delivers full power. This way it seems that his power output can be maintained longer than if he were doing a pure-double-push.

An interesting question now is how Chad would respond if he wanted to pass some skaters at this speed. Would he revert to a pure double-push during the pass? Some more video would help here.

Acknowledgments

Special thanks to Kim Hendrikse for taking the video and to Chad Hedrick for consenting to perform for the camera.

Video Tools

To work with Mpeg video like this it is often useful to be able to convert it to *.avi format. This can be done very nicely with Mpeg2Avi (1999 version 1.20), a free win32 console program. To change the frame rate for slow motion or other special effects try FMP144 (Fast Movie Processor, version 1.44), a powerful but free and simple video mini-editor for windows. Both of these programs are available at http://www.gromada.com.

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