EXPERIMENTS AND FORMULAS CONCERNING AGE HANDICAPPING IN SKI RACES

(Update—Oct/2006)

Peter Hoffman

Experimental handicapping has been applied to Masters races in Southern Ontario for nearly 10 winters. In the past few years, the handicapping formula below has been the basis for producing an overall masters champion, both male and female, for Ontario. It seems time for an updated write-up concerning some recommendations I made about 10 years ago. These were based partly on Ontario results around that time, as well as on very helpful discussions with Derek Walton, Karl Kinanen and Dale Foley, and mainly on results from the Norwegian Worldloppet race. This has been the basis for the handicapping used, and it seems to have been reasonably successful and accepted by the athletes involved and the race officials. This document contains also remarks about more recent results from Norway which confirm the reasonableness of the factors used. And finally, we give a very brief discussion of the effect of altitude gain as a possible variable in a formula for age-handicapping, preliminary to a more careful study on which I have embarked. This is somewhat relevant to the Masters World Cup policies, which at present mandate courses with about half the 'real' World Cup standards.

The recommendations concern HOW to handicap (but not really WHETHER to do it, aspects of which are discussed in the first section below). The second section gives a table of handicapping factors. This is followed by a suggested shortcut for avoiding the table by using the formula, which would be usable by race statisticians with a spreadsheet or a (minimally) programmable calculator. Then, for skiers with the patience to read further, the rest of the article is the justification for various aspects of what is being recommended. It seems clear to me that this whole issue is fairly subtle. Derek has some other possibilities, in areas where we didn't completely agree. As the years roll on, it's likely that additional data will make it possible to refine the handicapping factors used, but probably not by enough to seriously affect any results handicapped using the methods suggested here. But it has been a pleasant surprise that in the 10 years so far, the data has continued to agree very well with the original suggestions.

DIFFERENT TYPES OF RACES

There seem to be four possibilities. Organizers of different races will possibly want to use different ones of these, depending on circumstances. I'd imagine that maximizing the number of entrants would be foremost in their minds when choosing which alternative to use.

(1) Lump all Masters skiers into one group, and decide the results using handicapping.

(2) Leave the age classes as usual (or perhaps use wider classes), and handicap within each age class.

(3) As in (1), except no handicapping.

(4) As in (2), except no handicapping.

So (4) is what is now done in all but a few races, and probably (3) is the least satisfactory of the alternatives.

Doing (1) is clearly good when the number of entries is small, so that there are only a few racers in each age category. As long as a race director has strong faith in the system of handicapping, I think that (1) is the appropriate course of action even in a larger race. However, my experience in this sport is very limited. If (1) is favoured, I think it is important for race directors to read all of this article, so that they realize where the factors come from, and what the various alternatives which I have rejected are (and why I've rejected them).

Finally, possibility (2) is a more conservative method of handicapping, with less possibilities for 'injustice'. It doesn't solve the problem of small entries, and will affect the unadjusted standings in the lower age groups very little. But in the older age groups, it will solve the problem of the rather large expected decline (approaching 3% per year by age 70) which puts older entrants within the group at a considerable disadvantage. To do (2), just apply the method below, but keep the age classes separate. When the adjusted times are posted, skiers will have the possibility of comparing themselves to those in other age categories, if they wish, a sort of private version of alternative (1).

HANDICAPPING METHOD

The method suggested is in (A) and (B) :

(A) Do NOT change the finish time of any skier between the ages of 30 and 40, inclusive; and

(B) REDUCE the time of any skier over 40 as follows . First convert the actual finish time from [min : sec] to [minutes to two decimal places]. Then multiply that time by the factors given in the table below in column 4. (The factors are given to way more decimal places than makes sense, because I'm a klutz with spreadsheets!)

These factors are of course less than 1, and they decrease as age increases. So far there seems to be no evidence that women should have different factors than men. There is, however, much more data for men. The factors come from a simple formula, described after the table, and very useful with a spreadsheet or calculator to speed things up and reduce possibilities of error. The factors are only given up to age 75 in this table, at which age the formula becomes inappropriate. Further down, we another table for ages up to 90. It agrees with the previous one reasonably well, and has the advantage of not giving totally ridiculous numbers for the oldest ages (such as 'infinity' for age 90, which the original formula would give)! There seems little prospect of entrants in the next year or two for whom the second table would be needed, and data supporting the old-age end of this second table is very weak, as explained much further below. (If you only want to know WHAT is being suggested, and not WHY, you can stop reading now, except for perusing the two tables.)

TABLE OF FACTORS

age →	handicap %	divide factor	mult. factor
40	0	1	1
41	0.469387755	1.004693878	0.995328052
42	0.958333333	1.009583333	0.990507635
43	1.468085106	1.014680851	0.985531558
44	2	1.02	0.980392157
45	2.555555556	1.025555556	0.975081257
46	3.136363636	1.031363636	0.969590128
47	3.744186047	1.03744186	0.963909437
48	4.380952381	1.043809524	0.958029197
49	5.048780488	1.050487805	0.951938704
50	5.75	1.0575	0.945626478
51	6.487179487	1.064871795	0.939080183
52	7.263157895	1.072631579	0.932286555
53	8.081081081	1.080810811	0.925231308
54	8.944444444	1.089444444	0.917899031
55	9.857142857	1.098571429	0.910273082
56	10.82352941	1.108235294	0.902335456
57	11.84848485	1.118484848	0.894066649
58	12.9375	1.129375	0.88544549
59	14.09677419	1.140967742	0.876448968
60	15.33333333	1.153333333	0.867052023
61	16.65517241	1.166551724	0.857227313
62	18.07142857	1.180714286	0.846944949
63	19.59259259	1.195925926	0.83617219
64	21.23076923	1.212307692	0.824873096
65	23	1.23	0.81300813
66	24.91666667	1.249166667	0.800533689
67	27	1.27	0.787401575
68	29.27272727	1.292727273	0.773558368
69	31.76190476	1.317619048	0.758944705
70	34.5	1.345	0.743494424
71	37.52631579	1.375263158	0.727133563
72	40.88888889	1.408888889	0.70977918
73	44.64705882	1.446470588	0.691337942
74	48.875	1.48875	0.67170445
75	53.66666667	1.536666667	0.650759219

The percentages given in column 2 of the above table are the easiest thing for the reader to consider, when forming an opinion about the merits of this method. They give the accumulated expected decline up to the corresponding age, given in column 1. These percentages are based on data from the Norwegian Birkebeinerrennet. I used these

annual ski races from the first half of the 1990's (more detail in the next section), and, as mentioned earlier, the data from the 10 years after that continue to agree very well with that original attempt. The formula for these percentages is a simple one:

% = 23(age - 40)/(90 - age) .

That is: subtract 40 from your age; now take 90 minus your age; divide the second number into the first, and multiply by 23. The main virtue of this formula is that it can be built right into a spreadsheet or programmed very easily on a calculator to produce results quickly, and with no possibility of copying error (since the table is then avoided). The formula also has the minor virtue that you can do rough calculations in your head, while negotiating the DVP loop, say!

The numbers in column 3 of the above table are just 1 + (%/100). They can be used as numbers by which you DIVIDE your time, if preferred. Thus, the factors in column 4, by which you MULTIPLY, are just the reciprocals of the ones you divide by. For example, if the percentage for a given age is 25%, then the number you would divide by is 1.250, whereas the factor you multiply by is .800.

Finally, here is the table of factors which I'd suggest to use for the oldest classes of skiers. They are NOT given by the above formula, but by a much messier one which, for all practical purposes, agrees well enough with the formula above up to age 74. It is not worth writing down that messy formula here, as the advantages claimed for the simple formula disappear. I'd be happy to provide details about this messier formula to any interested reader. The number of skiers over 74 is not likely to be large, however, so the process of multiplying their times by the factors below will neither be tedious nor prone to error. However I personally have every intention of making all the rows in that table relevant once, over the next 25 years!

TABLE OF FACTORS (Age over 75)

age	Handicapping	Factor
40	0.00%	1.000
41	0.38%	0.996
42	0.81%	0.991
43	1.29%	0.986
44	1.81%	0.981
45	2.38%	0.976
46	2.99%	0.971
47	3.65%	0.965
48	4.35%	0.960
49	5.10%	0.954
50	5.90%	0.948
51	6.74%	0.941
52	7.63%	0.934
53	8.57%	0.927
54	9.55%	0.920
55	10.58%	0.913
56	11.65%	0.905
57	12.77%	0.896
58	13.93%	0.888
59	15.14%	0.879
60	16.40%	0.869
61	17.70%	0.859
62	19.05%	0.849
63	20.45%	0.838
64	21.89%	0.827
65	23.38%	0.815
66	24.91%	0.802
67	26.49%	0.789
68	28.11%	0.775
69	29.78%	0.761
70	31.50%	0.746
71	33.26%	0.730
72	35.07%	0.713
73	36.93%	0.695
74	38.83%	0.677
75	40.78%	0.657
76	42.77%	0.637
77	44.81%	0.615
78	46.89%	0.593
79		0.569
80		0.544
81		0.518
82		0.490
83		0.462
84		0.431
85		0.399
86		0.366
87		0.331
88		0.294
89		0.255
90		0.215

WHAT IS (AND SHOULD BE) THE DATA ?

The Norwegian Birkebeiner has age classes which, from 30 onwards, are the usual five year classes. There is also an elite class, and of course separate classes for women and men. The number of participants in the men's classes up to 65-69 is in the several hundreds, over 500 in most classes. The standards are very high, the top bunch being all near the top in the world in their age group, and approximately half the skiers in each class getting within 25% of the average of the top five in their class. So there are probably over 100 skiers in each age class who would easily get in the top half of their class in any World Masters race. The field at World Masters races are of course much smaller. Getting within 25% as above is the goal for most at the Birkebeiner, so it was easy for me to obtain that data for the races from 1991 to 1995. I would like to thank Greg Lutick for 1996 data. I myself had been there in 1995.

From that data for men, I calculated the ratios of the average top five in each class from 45-49 up to 70-74 to the average top five in the 40-45 class. This gives a sequence of numbers between 1 and 2, one for each year of the race. This number I assigned to the lowest age in each class, that is: 45, 50, 55, 60, 65, and 70. I then averaged these numbers over the different years, to get one number for each of the above six ages, together with the number 1.000 for age 40. These are the numbers to which the 1 + (%/100) in one column of the first table should be a good approximation. Finally, with much experimentation, I singled out the formula of the previous section. My earlier note in the Newsletter had a similar formula, giving slightly lower handicaps, since I wondered whether the length of the Birkebeiner led to a larger deficit for older skiers. But discussions with Derek helped to convince me that we should get as close to the actual data as possible, at the same time keeping the formula as simple as possible. We agreed at the time that it would be a formula worth experimenting with this winter, so that's what you'll see below in some examples. The numbers from the formula in the first table of the previous section all differ from the average data as obtained above by much less than 1 in 100 (i.e. 1%, but don't confuse that with the earlier %'s). The same would therefore be true of the factors which I am suggesting to multiply by. Another, theoretical, advantage of having a formula is that it produces numbers for all the other ages (41, 42, 43, 44, 46, 47, etc.) which increase in a mathematically sensible manner.

I made similar calculations with the women's results. Here the participation rate is much smaller, so the data jumped around quite a bit. However there seemed to be no direction in which to modify the factors derived from the men's data which would appear to make handicapping more fair for women, so I'm suggesting that the same factors be used. Probably any system for general handicapping is likely to be 'unfair' more often in individual cases for women than men, due to various circumstances of life which lead to more rapid physiological changes for women than men, at ages that vary widely from one person to the next.

Actually, the Birkebeiner data for men from one year to the next also jumps around quite a bit, despite the fact that so many participate, pretty well the same people from year to year. It is clear that one must be very careful about drawing conclusions from small amounts of data.

Here are some opinions on choice of data in general.

(1) Only data involving the top Masters skiers in the world should be used. I assume that we are trying to measure some decline with age only for the best trained athletes. (Other sports are too different to be useful here, except possibly to take a look at very old runners, 75 and up, in desperation because data is almost non-existent for skiers this old.) Furthermore, non-elite participants sometimes do not attempt to ski at absolute maximum speed in some races, and it is, in any case, impossible to decide precisely what we mean by an average skier. If and when handicapping is done in our local races, obviously we want to see that nothing ridiculous happens. But I don't think anyone will be insulted by me saying that the number of world class Masters skiers in Ontario is not large enough to produce reliable data for actually altering the factors used, only for checking whether some rethinking is needed.

(2) It makes sense only to compare skiers of different ages in the same race (NOT different years). In particular, there is a serious difficulty with World Masters results themselves, in that skiers over 60, and then again over 70, ski a shorter distance and (at least some years) a less demanding course. The Worlds can be used, particularly for the range from 40 to 59, to see whether the factors or formulas used are obviously in need of modification. It is fun for a skier to compare his or her own performance from year to year, but this is useless for producing reliable data, due to improvements in equipment and changing snow conditions from year to year.

(3) It is probably much better to use an average top few for data, as I have done, rather than winning times, for at least two reasons. Firstly, a winner who was well ahead near the end, and has another race soon, will possibly slow down a bit, messing up the comparison with other age groups in that race. Furthermore, a few really exceptional individuals can make a very big difference, throwing things off. (An example is Gunnar Transmoen who always wins, usually by a lot— he was only about 15 % behind the Norwegian World Cup skier Terje Langli at the 1995 race, despite being in the 65-69 class! Another is Ole Kvaale, who beat about half the World Cup women in 2002 when it was simultaneously a WC race, despite him carrying an extra 3.5 kg. pack—they didn't—being about twice their typical age, and even skiing an extra 100 m. I have the misfortune of being exactly the same age as him, so I do my private 'pin' calculation, using skiers placing 2nd to 6th, but still don't get very close!) Doing an average of the top 4 or 5 in a race will tend to smooth out these anomalies and give much more reliable data. On the other hand, if the entry is small, it is hard to do this and still just be using world class skiers. This is another problem with data from the World Masters, particularly older men's classes and women's classes.

(An amusing sidenote, relevant to 2007, not 1997 when the above was written, is that Tronsmoen went out on wooden skis in one recent year, and did NOT win, for once. But he quickly and decisively rectified that in subsequent years, on modern skis again!)

AGE VERSUS COURSE PROFILE—A new project

I have recently obtained a relatively inexpensive instrument for getting accurate course profiles. It will be used at least on the Keskinada course and the Birkebeinerrennet course this year (2007). The guidelines concerning course profile and length by the World Masters association seem to be based more on opinion and preferences of a few skiers, than on any real data. I intend to analyze the relative results in easier (e.g. Engadin, Vasaloppet), versus medium (e.g. Keskinada, U.S. Birkebeiner. Marcialonga) versus harder (physically, not technically) courses (Birken), at least with respect to total altitude gain, in the next few years, so that some reasonably exact knowledge comes to exist in this area. My hypothesis was that altitude gain may be a bigger detrimental factor for older skiers, but that course length makes very little difference, in what would be appropriate handicaps. A quick look at recent Marcialonga data however seems to refute that, but more work is needed. If that hypothesis were the case, then using Birken data, as we have been doing, may be giving the oldest age categories slightly too much handicapping when used for 'easier' races. But that remains to be seen. I will ski in subsequent years at least the Vasaloppet and the Marcialonga, both classical races with very strong age-group fields, and measure more exact data myself on course profile, etc., before getting too dogmatic about any conclusions. One problem is that the Swedes don't seem too keen on a lot of age-group data; hopefully I can solve that problem—they certainly have a sophisticated timing regime from IBM.