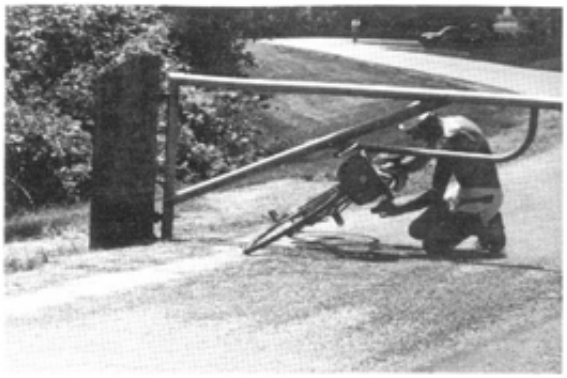
MEASUREMENT NEWS

September 1990 Issue #43



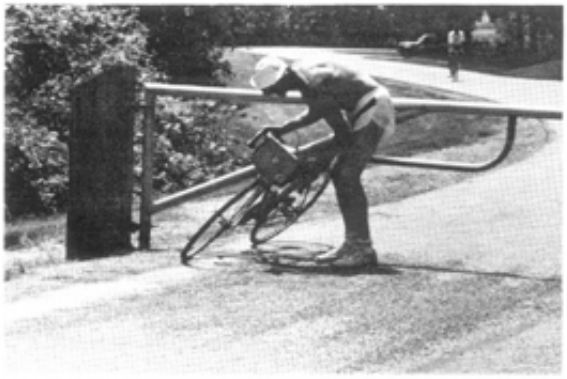


Photo sequence by Donny Roush - Ohio Runner

At the TAC/IAAF International Measurement Seminar, held in Columbus, Ohio, on June 16-17, John Disley demonstrates one way to measure across a gate.

See measurement summary inside.

MEASUREMENT NEWS

#43 - September 1990

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NEW APPOINTMENTS

John Sissala has been appointed National Road Race Course Certifier for the State of Maryland. He is now a final signatory. Nice going, John!

Elizabeth Longton is the new certifier for the State of Tennessee. She will work under the tutelage of Wayne Nicoll until she has acquired the experience which will permit her to become a Final Signatory. Welcome, Elizabeth!

TAC CONVENTION TOPICS

Is there something we are doing that we ought not to do? Are we neglecting things we should be doing? The TAC Convention is a good place to air these topics, and perhaps arrive at new policies. Bob Baumel has suggested that we have been flying by the seat of our pants on what to do after we validate. If the course (say a 10k) checks out at 10007, should we require that 3 meters be added? Or should we say "It passed - leave it alone?"

Another topic that arises comes from the recommendation to TACSTATS from Sally Nicoll (see her letter in this issue) that Pat Petersen's 1989 2:10:04 at London be accepted as the US Record. It will be our first on a foreign course. London cooperated handsomely in helping us get the data needed for ratification. Should we officially extend the same cooperation to foreign federations who may have athletes set national records at US races? It would be a nice gesture.

When a track needs to be measured, most of us wince. We have a steel-taping procedure, and it works just fine if there is a curb to measure around. If the track is uncurbed it's not so simple. It depends on the track having a regular geometry. As long as the bare minimum of measurements are taken (length and width), there is no confusion. However, when people get extra data, the answers often conflict. Should we simply measure uncurbed tracks using our bikes?

What about cones and monitors on maps? The book says we are to specify where they are to be. Is this going a bit farther than a map should go? Should the map define the course, and the race director decide how to make it happen, or is it our job to go beyond measuring and to enter the conduct of the race itself? See letter from David Reik in this issue.

CERTIFIED CALIBRATION COURSES

You may certify calibration courses just like any other course. Use the same numbering system as we use for regular courses. See letter from Bob Baumel.

TEXAS ROUNDUP

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A word of warning to all you serious runners who run only on TAC/RRTC-certified courses: be sure the race director lists his authorization number before you enter a race. Tom McBrayer, Texas and Louisiana Certification Chairman, recently brought it to our attention that a race advertised as TAC certified was not.

INSIDE TEXAS RUNNING does not list any races in its calendar as certified unless we can verify that fact. Last year we took a lot of flak from one race director who listed his course as certified because we warned our readers in "Roundup" that the paperwork had not been received by the certification chairman prior to the race. Although he was an advertiser, we felt our readers depend on us for such information, and told the advertiser as much. Sad to say, despite his angry assertion that the course would be certified by the race date, it never was.

"To me, when a race director says his course is certified when he knows it isn't, that's false advertising," says McBrayer.

ITR agrees. And although it has been our policy, as already stated, to list as certified only races with authorized numbers in our calendar, we will also insist in the future that all advertisers delete any such statement from their ads in **ITR** if proof is not provided.

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PETE

THE ONGOING BATTLE —

FROM INSIDE TEXAS RUNNING 9/90

TOM MCBRAYER

The Athletics Congress of the USA

The Governing Body for Athletics in the United State including Track and Field, Long Distance Running and Race Walking for men and women and boys and girls at all age levels.

SALLY H. NICOLL
Ragged Mountain Club
Potter Place, New Hampshire 03265
(603) [illegible]
(603) [illegible]

(603)735-5721

July 12, 1990

TACSTATS
915 Randolph
Santa Barbara, CA 93111

Dear Basil & Linda,

I have received a completed validation report package from Pete Riegel in support of the pending mark of Pat Petersen in the 1989 ADT London Marathon (UK89017PR). The package contains sufficient results information to support the application. If you do not have file copies of the results I will be happy to forward them to you.

Based on Pete's report it is my pleasure to recommend the 1989 Petersen mark be accepted and submitted for ratification by TAC/USA as a US Record.

To my knowledge this is the first mark set outside the continental US which has met all requirements necessary for ratification by TAC/USA as an American Record. The leadership of John Disley and Pete Riegel are gratefully appreciated in opening this new dimension to our athletes.

Sincerely,

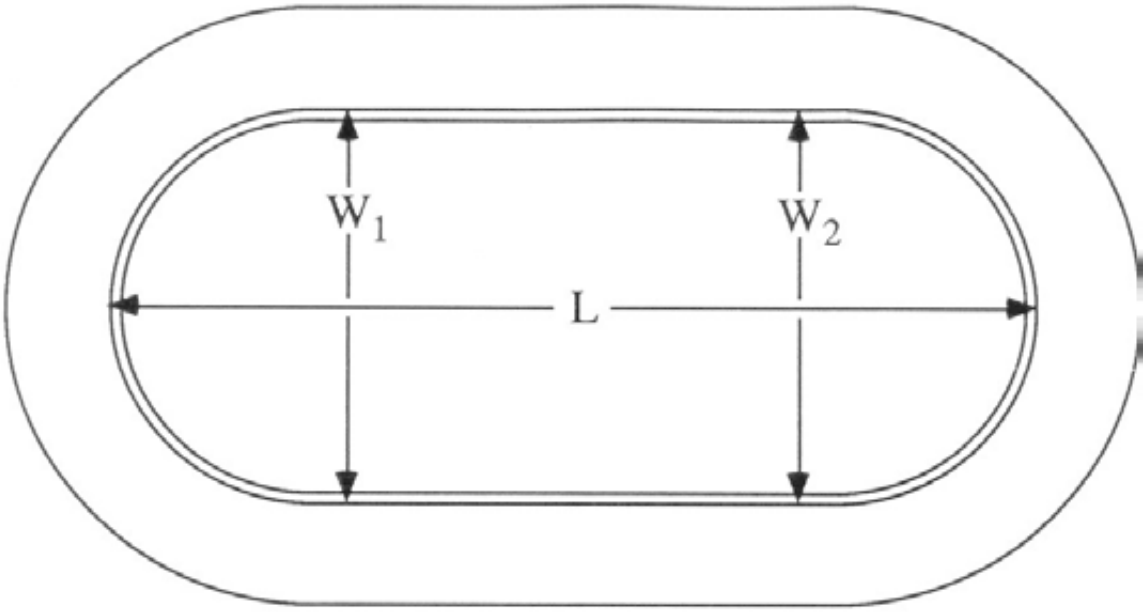
Sally

Sally H. Nicoll, Validations Chairman
Road Running Technical Committee, TAC/USA

cc: Riegel, Disley

How to Tape a Track

by Bob Baumel



If curb is suitable, then tape circumference directly along outer edge of inner curb. If not, then use "Length-Width" method: Measure distances L, W_1, and W_2 as shown above, and calculate circumference by the formula:

$$\text{Circumference} = 2L + \left(\frac{\pi}{2} - 1\right)(W_1 + W_2)$$

$$= 2L + 0.570796(W_1 + W_2)$$

Once you have the circumference (by either direct curb taping or Length-Width method), then:

If track is curbed, add 1.885 m (6.18 feet) for path 30 cm from curb, or
If track is uncurbed, add 1.257 m (4.12 feet) for path 20 cm from the line.

Notes:

1. Distances L, W_1, and W_2 in the Length-Width method are measured to the outer edge of inner curb or painted line defining the inside edge of the legal running surface.
2. Widths W_1, and W_2 should have endpoints near ends of straightaways, but **within** straightaways (**do not** waste time trying to locate junction of straight-away and curve).
3. For either direct curb taping or Length-Width method, tape every distance at least twice. (You may average the measurements.)
4. Use careful taping technique as described in the manual (include temperature correction).

RESULTS OF TAC/IAAF MEASUREMENT SEMINAR

Last issue showed preliminary results of the TAC/IAAF measurement seminar held in Columbus. Since then, complete results have been compiled and are shown in this issue.

Also included are the reports of Bob Baumel and Wayne Nicoll. They give a good summation of the weekend's activity.

As a result of the seminar, we now have ten US measurers appointed as "IAAF approved measurers." See below.

All measurement data is in a Lotus 1-2-3 file. Anyone wishing to use the data should get in touch with Pete Riegel. The file can be sent to you on a disk. There are lots of statistical games to be played with the data, and we'll be happy to see anyone's conclusions from it.

IAAF APPROVED MEASURERS

John Disley and Pete Riegel have finished evaluating the results of the recent IAAF measurement seminar, and the following is the complete listing of US "IAAF Approved Measurers":

Bob Baumel
Scott Hubbard
Tom Knight
Doug Loeffler
Tom McBrayer
Wayne Nicoll
Pete Riegel
Bob Thurston
Mike Wickiser
Jay Wight

Bernie Conway has been added as IAAF Approved Measurer for Canada.

George Tillson and Amy Morss attended the seminar as students rather than candidates. Their absence from this list is not a reflection on their abilities.

SUMMARY OF MEASUREMENTS - IAAF SEMINAR

Battelle-West Jefferson Recreational Facility - June 16, 1990

Weather - clear, sunny, 27-32 (C), 80-90 (F)

Calibrations were all performed on twin 300 meter on-course baselines.

One was laid out by Wayne Nicoll. It was checked by Bob Thurston, who obtained 300.01 meters.

The other was laid out by Bob Baumel. It was checked by Tom Knight, who obtained 299.98 meters.

These calculations assume the calibration courses were 300.00 meters.

All calculations are based on average constant without extra 1.001.

MEASURED LENGTHS OF VARIOUS SEGMENTS OF COURSE BASED ON RAW DATA

These lengths were calculated by Pete Riegel, using Lotus 1-2-3 spreadsheet program, and are based on raw measurement data submitted by each participant in a post-seminar report. In doing these calculations, it was Pete's intent to get the most exact answers that the data would support. Data is presented in the order it was received by Pete Riegel.

Here are the measured lengths of the full course, as determined by exact calculation, as well as the abbreviations that will hereafter be used for the measurers:

ABBREV	MEASURER	OVERALL LENGTH
PR	RIEGEL	5018.31
SH	HUBBARD	5017.46
JD	DISLEY	5018.51
MW	WICKISER	5019.75
ETM	MCBRAYER	5019.11
GT	TILLSON	5020.34
DL	LOEFFLER	5015.16
RT	THURSTON	5019.24
WN	NICOLL	5023.29
AM	MORSS	5021.20
BC	CONWAY	5016.95
JW	WIGHT	5016.42
BB	BAUMEL	5020.18
TK	KNIGHT	5019.10

	OVERALL LENGTH	ADJUST TO TURN	MEASURED LENGTHS START 1 KM	1 KM 2 KM	2 KM 3 KM	3 KM 4 KM	4 KM FINISH
PR	5018.31	-6.66	1007.41	1003.31	1002.46	989.39	1015.74
SH	5017.46	-6.23	1007.80	1003.06	1001.88	989.01	1015.71
JD	5018.51	-6.76	1007.62	1004.05	1002.12	988.95	1015.78
MW	5019.75	-7.38	1008.10	1003.87	1002.38	989.19	1016.21
ETM	5019.11	-7.05	1008.19	1003.28	1002.08	989.28	1016.29
GT	5020.34	-7.67	1007.90	1003.60	1003.02	989.52	1016.30
DL	5015.16	-5.08	1007.07	1002.58	1001.80	988.65	1015.06
RT	5019.24	-7.12	1008.54	1003.73	1002.20	988.94	1015.83
WN	5023.29	-9.15	1009.62	1004.47	1002.75	989.59	1016.85
AM	5021.20	-8.10	1009.82	1003.94	1002.37	988.63	1016.44
BC	5016.95	-5.98	1007.21	1003.35	1001.84	988.85	1015.70
JW	5016.42	-5.71	1007.38	1003.20	1001.91	988.73	1015.20
BB	5020.18	-7.59	1008.56	1003.81	1002.25	989.24	1016.32
TK	5019.10	-7.05	1008.24	1003.34	1002.52	989.17	1015.82
HIGH	5023.3		1009.8	1004.5	1003.0	989.6	1016.9
LOW	5015.2		1007.1	1002.6	1001.8	988.6	1015.1
SPAN	8.1		2.7	1.9	1.2	1.0	1.8
AVERAGE	5018.93		1008.10	1003.54	1002.26	989.08	1015.95
STD DEV	1.995		0.797	0.462	0.344	0.299	0.469

MEASURED LENGTHS - CONTINUED

	1 KM 1 MI	1 MI 2 KM	3 KM TURN	TURN 4 KM
PR	588.57	414.74	220.27	769.12
SH	588.88	414.18	221.02	767.98
JD	589.02	415.03	219.99	768.96
MW	589.12	414.76	220.25	768.94
ETM	589.04	414.23	220.47	768.81
GT	589.09	414.52	220.19	769.33
DL	588.54	414.04	220.22	768.43
RT	589.23	414.50	220.22	768.73
WN	589.83	414.65	220.33	769.26
AM	589.33	414.61	220.16	768.47
BC	588.78	414.57	220.39	768.46
JW	588.80	414.40	*	*
BB	589.17	414.64	220.25	768.99
TK	589.05	414.30	220.30	768.88
HIGH	589.8	415.0	221.0	769.3
LOW	588.5	414.0	220.0	768.0
SPAN	1.3	1.0	1.0	1.3
AVERAGE	589.03	414.51	220.31	768.80
STD DEV	0.314	0.254	0.233	0.364

* Wight reported no data for turnaround point.

DEVIATION FROM AVERAGE MEASURED VALUE, METERS

	OVERALL LENGTH	START 1 KM	1 KM 2 KM	2 KM 3 KM	3 KM 4 KM	4 KM FINISH	SPAN OF KM DEVS
PR	-0.619	-0.689	-0.232	0.200	0.310	-0.208	0.999
SH	-1.473	-0.299	-0.488	-0.374	-0.076	-0.237	0.412
JD	-0.416	-0.486	0.511	-0.137	-0.135	-0.169	0.998
MW	0.824	-0.008	0.332	0.127	0.110	0.263	0.339
ETM	0.177	0.083	-0.268	-0.178	0.200	0.340	0.608
GT	1.409	-0.208	0.059	0.759	0.441	0.359	0.968
DL	-3.772	-1.033	-0.962	-0.457	-0.431	-0.890	0.602
RT	0.311	0.434	0.188	-0.055	-0.139	-0.117	0.573
WN	4.361	1.518	0.931	0.494	0.512	0.906	1.024
AM	2.268	1.715	0.399	0.118	-0.454	0.490	2.169
BC	-1.979	-0.890	-0.196	-0.412	-0.233	-0.247	0.694
JW	-2.512	-0.726	-0.345	-0.345	-0.354	-0.743	0.398
BB	1.250	0.454	0.269	-0.008	0.158	0.378	0.462
TK	0.171	0.136	-0.199	0.268	0.092	-0.125	0.467

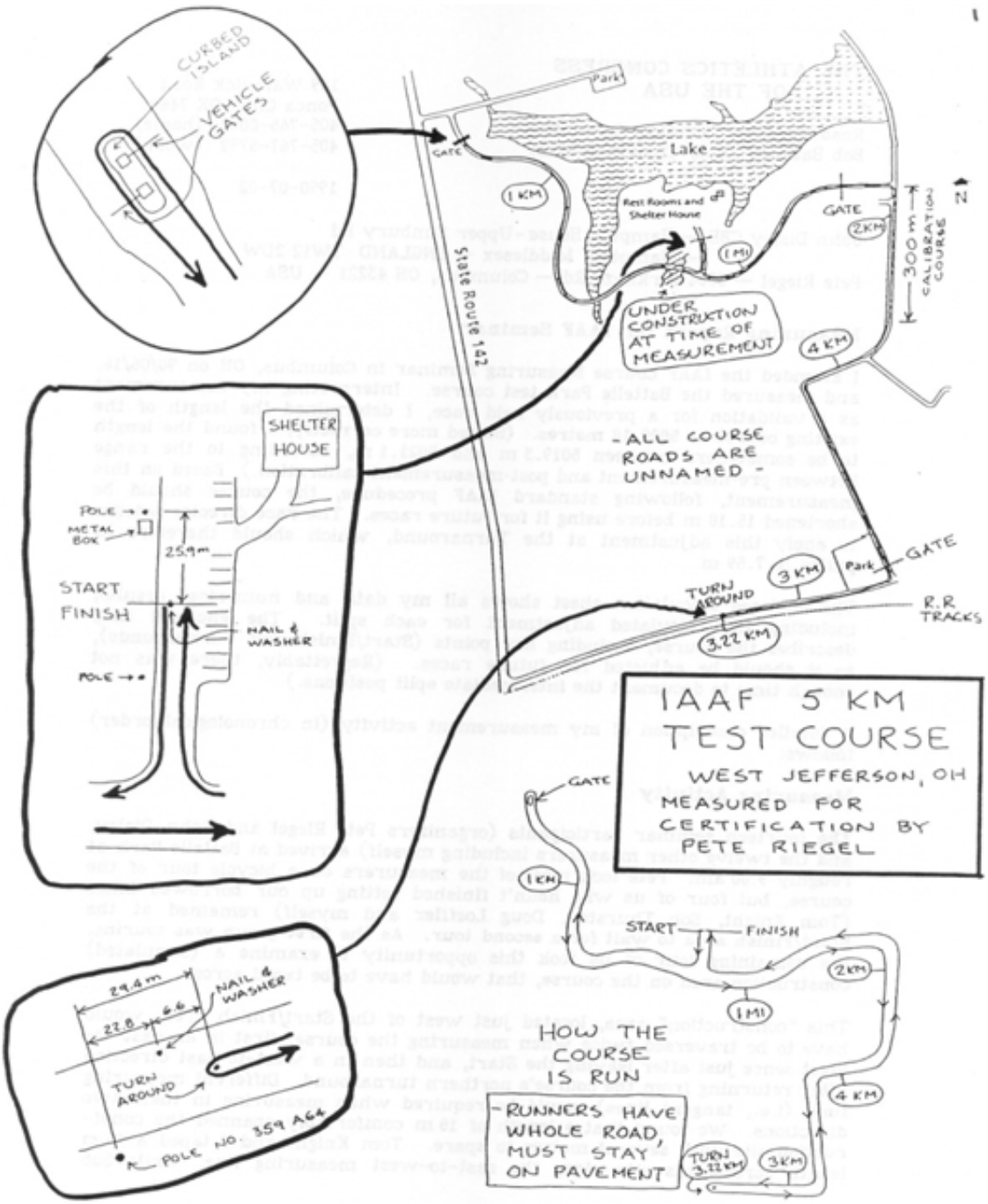
Average km span for 14 measurers = 0.765

CALIBRATION DATA AND CALCULATIONS

	AVERAGE CONSTANT	POSTCAL MINUS PRECAL CT/KM	PRECAL VARIATION COUNTS	POSTCAL VARIATION COUNTS	AVG VARIATION COUNTS	TIRE TYPE	BIKE
PR	9261.25	0	0.5	1.5	1	SURETRAK	MOTOBECANE
SH	9474.17	-1.67	1	0	0.5	PNEU	TREK
JD	9261.88	0.42	1	0.5	0.75	SURETRAK	MOTOBECANE
MW	9475.42	-2.50	0	0.5	0.25	GOODFOAM	NASHBAR
ETM	9924.38	-1.25	1	2.5	1.75	SOLID	FUJI
GT	9782.50	1.67	2	2	2	PNEU	RALEIGH
DL	9354.17	0	1	3	2	PNEU	FUJI
RT	9465.67	-0.33	1.5	1.1	1.3	GOODFOAM	NASHBAR
WN	9272.50	3.33	1	1	1	GOODFOAM	SUTEKI
AM	9529.38	-3.75	1.5	4	2.75	PNEU	PEUGEOT
BC	9310.83	-1.67	1	2	1.5	PNEU	RALEIGH
JW	9329.17	-5.00	1	0	0.5	PNEU	VISCOUNT/SEB
BB	9377.92	-3.33	1.5	1	1.25	PNEU	TARGA
TK	9344.17	0	2	0.5	1.25	PNEU	FUJI

AVG SOLID CHANGE -0.056 COUNTS/KM
AVG PNEU CHANGE -1.719 COUNTS/KM

1.27 COUNTS AVERAGE RANGE FOR 4 RIDES


CURBED ISLAND
VEHICLE GATES
Park
GATE
Lake
1 KM
Rest Rooms and Shelter House
GATE
2KM
1MI
300 m CALIBRATION COURSE
N
State Route 142
UNDER CONSTRUCTION AT TIME OF MEASUREMENT
4 KM
- ALL COURSE ROADS ARE UNNAMED -
SHELTER HOUSE
POLE
METAL BOX
25.9m
START
FINISH
NAIL & WASHER
POLE
3 KM
Park
GATE
TURN AROUND
R.R TRACKS
3.22 KM
IAAF 5 KM TEST COURSE
WEST JEFFERSON, OH
MEASURED FOR CERTIFICATION BY PETE RIEGEL
GATE
1KM
START
FINISH
2KM
1MI
4 KM
3KM
TURN 3.22 KM
29.4m
27.8
6.6
NAIL & WASHER
TURN AROUND
POLE NO. 359 A64
HOW THE COURSE IS RUN
- RUNNERS HAVE WHOLE ROAD, MUST STAY ON PAVEMENT

THE ATHLETICS CONGRESS
OF THE USA

Road Running Technical Committee
Bob Baumel, Vice-Chairman West

129 Warwick Road
Ponca City, OK 74601
405-765-0050 (home)
405-767-5792 (work)

1990-07-02

John Disley CBE — Hampton House-Upper Sunbury Rd
— Hampton, Middlesex — ENGLAND TW12 2DW
Pete Riegel — 3354 Kirkham Rd — Columbus, OH 43221 — USA

Measuring Report for IAAF Seminar

I attended the IAAF Course Measuring Seminar in Columbus, OH on 90/06/16, and measured the Battelle Park test course. Interpreting my measurement as a validation for a previously held race, I determined the length of the existing course as 5020.18 metres. (Stated more correctly, I found the length to be somewhere between 5019.3 m and 5021.1 m, according to the range between pre-measurement and post-measurement calibration.) Based on this measurement, following standard IAAF procedure, the course should be shortened 15.18 m before using it for future races. The race director wishes to apply this adjustment at the Turnaround, which should therefore be pulled in 7.59 m.

The enclosed calculation sheet shows all my data and numerical results, including the calculated adjustment for each split. The enclosed map describes the course, including key points (Start/Finish and Turnarounds), as it should be adjusted for future races. (Regrettably, there was not enough time to document the intermediate split positions.)

A detailed description of my measurement activity (in chronological order) follows:

Measuring Activity

The fourteen seminar participants (organizers Pete Riegel and John Disley, and the twelve other measurers including myself) arrived at Battelle Park at roughly 9:00 am. Pete took most of the measurers on a bicycle tour of the course, but four of us who hadn't finished setting up our borrowed bikes (Tom Knight, Bob Thurston, Doug Loeffler and myself) remained at the Start/Finish area to wait for a second tour. As the first group was touring, the remaining four of us took this opportunity to examine a (simulated) construction area on the course, that would have to be taped across.

This "construction" area, located just west of the Start/Finish area, would have to be traversed twice when measuring the course: first in an east-to-west sense just after leaving the Start, and then in a west-to-east direction after returning from the course's northern turnaround. Different measuring lines (i.e., tangent lines) would be required when measuring in these two directions. We found that a length of 15 m comfortably spanned the construction site with several metres to spare. Tom Knight and I taped a 15 m length across this site along the east-to-west measuring line, while Bob

Thurston and Doug Loeffler taped a similar interval along the west-to-east measuring line. The endpoints of both intervals were marked so they could be easily used during the bicycle riding.

Then the first tour group returned, and the four of us who had stayed behind went out with Pete for our own tour of the race course. In this process, we familiarized ourselves with the course, and learned how runners were permitted to run it.

The next step was to lay out a pair of 300 m calibration courses, along the eastern and western edges of a straight north-south portion of the race course that included the 2 km mark. Corresponding to our responsibilities in the US course certification program, Wayne Nicoll headed up the initial layout of the Eastern cal course, while I had similar responsibility for the Western cal course.

I began work on the western cal course at 10:55 am, leading a 3-measurer team consisting of Doug Loeffler (rear tapeman), Jay Wight (lead tapeman), and myself (endpoint marker). Measured pavement temperature was 31°C. We used a 60 m tape owned by Bob Thurston. (Note: In the meantime, Bob Thurston did a measurement of the eastern cal course using a 30 m tape owned by me!) We set a nail at the northern endpoint, and laid out 5 tape lengths with Thurston's 60 m tape, pulled with a tension of 50 newtons using a spring tension handle. (The 50 N figure was specified by markings stamped on the tape.) Then we shortened the southern endpoint by 3.8 cm, based on the measured 31°C temperature, and we set a nail at the adjusted position.

Our resulting 300 m course was checked by a team led by Tom Knight, using a 30 m tape owned by Tom. They found the distance (corrected for temperature) between our two nails to be 299.978 m. The discrepancy of 2.2 cm is just 1 part in 13 600, which is well within reasonable tolerance. (The nominal US government accuracy standard for steel tapes is 1 part in 12 000.) For greatest accuracy, it would probably have been best to average Tom's and our measurements. But for the sake of simplicity, the distance between the nails was taken as an even 300 m for all subsequent calculations.

I don't have any data on the measurement of the Eastern cal course, although I understand that it was more confused than our measurements of the Western cal course. I believe that a total of five measurements were taken of the Eastern cal course.

I did all my bicycle measuring, including precalibration of the bike, one ride of the race course, and postcalibration of the bike, between 11:50 am and 12:47 pm, using a bicycle borrowed from Bernie Conway. This was actually the same bike I used last Fall when checking the Springbank Road Race course in London, Canada. (See my article in Jan 1990 *Measurement News*.)

In calibrating the bike, I used both the eastern and western cal courses. In both Precal and Postcal, all my odd-numbered rides were southbound on the western cal course, while my even-numbered rides were northbound on the eastern course. My northbound rides averaged 0.75 counts more than my southbound rides. This was probably *not* due to any significant difference in length between the two courses; I think it occurred because Wayne laid out

his cal course farther from the road edge, at a distance that felt unnatural to me, so I tended to deviate from a straight line when riding it.

In riding the race course, I started and finished at the 2 km point instead of the Start/Finish, since the 2 km point was right on the calibration course. I tried to ride a fair line, taking the inside edges of curves at 30 cm from the curb as well as I could estimate it. (This differs from standard layout measurements for TAC certification, where I would normally ride a tighter line.)

Actually, this course has no real curbs at all (except at the card-key gate—northern turnaround), but Pete Riegel painted lines along the inside edges of some corners, intended to *simulate* curbs.

At the simulated construction site, I used the 15 m taped intervals measured previously. I simply carried the bike from the mark at one side of the construction site to the corresponding mark on the other side while holding the front wheel locked. Then, when working up my results after I finished measuring, I explicitly included the 15 m taped distances in the calculations.

At the course's southern turnaround, I followed Pete Riegel's instructions by simply riding up to the point and turning around the bike on the spot (which is the procedure in the TAC Course Measurement manual). Thus, I did not make any allowance for extra distance covered by a runner when circling around the turnaround cone.

In riding the course, I needed to pass through locked gates on five occasions: These consisted of two large metal gates inside the park (each traversed in both directions), and the card-key operated gate at the park entrance at the course's northern turnaround. I was able to handle three of these five gate crossings (namely, the card-key gate and both crossings of the internal park gate at the course's southeast corner) by simple sideways offsets, as illustrated on page 16 of the IAAF measuring manual (draft text dated March 7, 1990). A simple offset could be used at the southeast gate because the central portion of this gate was high enough to pass my bike under (although this central portion was not on the measuring line, thus the need for an offset).

For the two crossings of the internal park gate between the 1.609 km and 2 km marks, I used the technique described on page 18 of the IAAF draft text. In this method, the bike is ridden up to the gate, and is then picked up and carried *backward* a distance of one bike length while holding its front wheel locked. Then it is rolled forward through this one-bike-length distance, so as to compensate for distance that cannot be ridden because of the locked gate.

Actually, the procedure on page 18 of the IAAF draft text is not quite correct, as it fails to account for the width of the gate. Therefore, I actually carried my bike backward through a distance of one bike length *plus the gate width* (by eyeball estimate). Note that if you use the manual's technique for five gate crossings, and fail to account for the gate widths, then the error could add up to around a whole metre.

After completing the bicycle measuring, I returned to the pavilion at the Start/Finish area where I had lunch, did my preliminary calculations, and turned them in to Pete Riegel. Then I realized that I still needed some documentation of the Start/Finish and Turnaround points for my course

map, so I got back on the bike and rode to the relevant points. (Note that with a little more foresight, I could have gathered that documentation during my measuring ride, making this additional trip unnecessary.)

At the course's southern turnaround, I obtained a (taped) distance of 22.34 m between the (existing) turnaround point and telephone pole 359A64 Later, I heard Pete Riegel describe this distance as 22.8 m. Thus, Pete's and my measurements of this short interval between the turnaround and telephone pole differed by nearly half a metre. The main reason for this discrepancy is that the road between the turnaround and telephone pole has some *curvature*. I have chosen to use my own (smaller) measurement of this interval because it makes the final race course safer; i.e., a race director using this distance to re-locate the turnaround will make the course a little longer.

In reality, however, it really doesn't matter how well we document the Start/Finish and Turnaround locations, because this course is still inherently non-reproducible due to the arbitrary simulated "curbs" painted by Pete Riegel at the corners!

General Observations

My immediate reaction after completing my measuring ride was a feeling of insecurity about whether I had measured all the locked gates correctly. I was worried about parallax errors, and my eyeball estimations of gate width. Worse yet, what if I completely forgot to include the extra bike length when using the technique from page 18 of the IAAF-draft manual? Then my measured distance would be off by nearly two metres for each gate where this happened.

Thus, I felt the measurement of this course to be non-robust because of the five gate crossings, particularly if the technique on page 18 of the IAAF draft manual is used for all five gates. Of course, we did have fourteen different people measuring this course, so if anybody actually dropped a whole bike length at one of the gates, it will probably become clear once we have compiled everybody's raw data for every measured point. But if this were a real validation situation with only *one* measurement, I would tend to lack confidence in the result.

Could we have dealt with the locked gates in a more robust manner? The most accurate procedure would have been to handle the gates the same way as the construction site; i.e., mark points on either side of the gate, and tape the distance between those marks. While this might seem like overkill, it would have the following advantages:

1) Greater Confidence: Everything is written down—the counter readings at both marks and the taped distance between the marks. So you know afterwards exactly what you did.
2) Avoids Parallax Error: Instead of sighting down the front of the front wheel and the back of the back wheel (with different, non-cancelling parallax errors), you simply sight down the center of your front axle (at both marks), just as you *always* do while measuring.
3) Explicitly Accounts for Width of Gates.

Because of these advantages, I think that in post-race validation situations, locked gates ought to be handled by taping through them. (Indeed, this is precisely what I did in November 1987 when validating the Mohawk Park 12 km course in Tulsa, Oklahoma, which had three locked gates at the time of my measurement.) A more approximate method, such as that illustrated on page 18 of the IAAF draft manual, is acceptable in simple pre-race layout measurements because the most likely errors in such methods (such as forgetting to roll the extra bike length) tend to be in the "safe" direction; i.e., they make the laid-out course longer. Similarly, it's OK to neglect the gate width in a layout measurement, as this also makes the course longer.

The aspect of this measuring occasion that I found most disturbing can be seen on the preliminary results sheet distributed by Pete Riegel that evening. The fourteen measurements ranged from 5015.2 m to 5023.2 m, which is a span of 8 metres. That span is 60% greater than the 5-metre Short Course Prevention Factor that we use for a 5000 m race. This means that if some of these measurements were used to lay out a course at 5005 m, then other measurements would find the laid-out course to be shorter than 5000 m. In fact, a simple statistical calculation (which I will probably write up in detail in *Measurement News*) indicates that if you randomly pick two measurements from this population of measurers, the probability is about 8% that the two selected measurements will differ by more than 5 metres.

Perhaps you will say that this isn't a problem because in standard IAAF procedure, once a course is "certificated" by an IAAF-approved measurer prior to the race, there isn't any requirement for post-race remeasurement. The course will never be found short in a post-race remeasurement because no such remeasurement will ever be made! But this is a specious answer because the method will not be credible unless an expertly laid out course can reliably withstand checking by another expert measurer. Regardless of standard procedure, there may be situations where post-race remeasurement is warranted by questions that arise about a course, even though the course had been IAAF-certificated prior to the race.

A large part of the problem was that, in the present exercise, a single measurement was intended to serve as *both* a validation and a layout. I wrote in my "Larger vs. Average Constant" essay (printed in May 1990 *Measurement News*) that "pre-race layout measurements and post-race validation measurements serve very different purposes." For this reason, many TAC Certifiers will ride the course differently in a validation or layout (cutting corners more tightly in a layout). When told that their single measurement would have to serve as both validation and layout, it's possible that some of the participants (such as Wayne Nicoll) were thinking more in a "validation" mode, while others (such as Doug Loeffler) thought more in a "layout" mode.

Let me hasten to add, however, that the agreement of our 14 measurements, viewed realistically, was excellent given the curviness of this course. According to Pete Riegel, the curves on this course add up to about 2300° (or about 40 radians). By way of comparison, I did a different measurement four years ago of another course with about 2300° of curves, with an Oklahoma measurer whom I consider quite good (although not quite in the same class as the participants in this seminar). I "beat" that measurer by 14.5 metres.

Viewed in this light, a spread of only 8 metres in 14 separate measurements is not bad at all.

The problem is not in our measurement results, but rather in current IAAF procedures which specify precisely the same method of calculation for layout and validation measurements, and allow a spread of only 0.1% between the layout point and validation rejection point, with no other safety factors or tolerances. In TAC we have additional safety factors in layout (larger constant; require at least two measurements and choose "better" one), and we now allow a slight negative tolerance (0.05%) in validation. These procedures have evolved over a period a years, and some (particularly the negative tolerance in validation) involved some very emotional debate.

Pete Riegel has remarked that when we in TAC/RRTC were bitterly debating the validation tolerance question several years ago, most measurers elsewhere in the world just yawned, as if we were arguing about angels on the head of a pin. The present exercise shows that we were addressing a real problem; we weren't arguing about angels dancing on pins.

In raising these points, I do not wish to imply that IAAF must completely revamp its procedures before proceeding further with its certification program. I agree with Pete that right now, it's most important to have *some* reasonably meaningful IAAF measurement procedures in place, and to establish procedures for IAAF road records as soon as possible, even if these procedures aren't perfect.

I point out only that some of the current IAAF procedures haven't been thought out as fully as possible. It would be great if all the lessons learned by TAC over the years could be absorbed instantly by IAAF. But I suppose that IAAF will need a number of years to refine its procedures until these issues have been adequately dealt with.

Before concluding this report, I want to say how grateful I am to Pete and Joan Riegel for hosting this event, and to John Disley for traveling from England to officiate. It was a great pleasure meeting John, whom I had known only by correspondence for the past five or six years. I was also very happy to meet five of the US measurers whom I did not know previously, and to renew acquaintances with all the other measurers. (In one case, namely Bernie Conway, that acquaintance goes back fourteen years when we both belonged to the same running club in London, Canada.)

Finally, I share Pete Riegel's sentiment when he wrote that he hadn't had as much fun since the Los Angeles Olympic Marathon measurement. We have now collected a dataset of 14 measurements that is, in many ways, better than the Los Angeles dataset. The present measurements were more nearly independent, there were no "conga lines" of bicycles when taking counter readings, and the weather was far more constant. This dataset may provide material for many more studies of course measuring technique.

Sincerely,

Bob

Bob Baumel

The Athletics Congress of the USA

The Governing Body for Athletics in the United States including Track and Field, Long Distance Running and Race Walking for men and women and boys and girls at all age levels.

WAYNE B. NICOLL
Ragged Mountain Club
Potter Place, New Hampshire 03265
~~(603) 224-0413~~
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(603)735-5721

26 June 1990

Peter S. Riegel 3354 Kirkham Road, Columbus, OH 43221
John I. Disley CBE Hampton House, Upper Sunbury Rd, Hampton
Middlesex, England TW12 2DW

Dear Pete and John,

Enclosed is the information Pete requested from the seminar. I thought it went very well and was a good learning experience for all of us.

A few thoughts on validations. Having performed a considerable number of validations since Pete introduced me to the process in 1985, I developed a validation philosophy which I felt was a means of applying fairness to the measurement. I am now beginning to question that approach.

In our revised TAC/USA measurement manual, we describe the path to be along the shortest possible route, coming within 30 centimeters of edges and curbs. In practice, most knowledgeable measurers ride closer than 30 cm to be assured their measurement would have little possibility of coming up short. On a validation, however, it seems unfair for a validator to ride inside of the 30 cm line. On most validations where I have been accompanied by skilled measurers, my results will reflect the longest distance achieved by any of the riders. I have made a special effort to ride what I felt was a path at or outside of the 30 cm line when riding close to curbs, barriers, and road edges. For example, on 28 October 1989 I validated the Robert Moses 2K racewalk loop in Niagara Falls, NY. I was accompanied by Bob Edwards (PA certifier) and David MacPhee, a measurer of proven skills (not the measurer of record of this course). The results were: Bob - 1.9998K, Dave - 1.9991K, Wayne - 2.0010K. Had Bob been the validator, the validation would have had to be reviewed by the board consisting of Riegel, Baumel, and Nicoll. If Bob had been performing an IAAF validation, the course could have been considered short.

The results at the recent IAAF Measurement Seminar reflect my approach of not riding within the 30 cm line. I found myself measuring during the lunch hour alone. I was able to concentrate on achieving a fair measurement. As I finished up I felt I had perhaps negotiated the course a little too tightly. Yet the group results reflect my ride as the longest. It is my opinion that most certifiers performing as validators have become so conditioned to tight riding that they are unable to ride with a 30 cm limit in mind. They are imbued with the

competitive notion that the best rider is the one with the shortest measurement. The wide disparity between my figures (longest) and that of Doug Loeffler's (shortest) really concerns me. There should not be a difference between two skilled measurers of 8 meters on a 5K measurement. When Doug and I have measured together we have not had that significant a difference.

It does not appear to be a problem for USA domestic validations since we are already willing to consider acceptance of a US record run on a course that may reflect as being up to .05% short. It may present problems on an IAAF measurement if validators typically ride tighter than 30 cm. The IAAF rules, to my knowledge, would not find a record acceptable from a course that validated at less than the advertised distance.

I am questioning whether or not I should continue my attempts to ride "fairly" on USA validations. If it has not already been accepted, I would suggest that IAAF validation review policies might also allow for .05% shortness and no attempt be made to condition validators to ride at the 30 cm limit as I have been attempting to do. I would appreciate your thoughts on this subject.

Sincerely,

Wayne B. Nicoll
Vice Chair, East
RRTC

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The Governing Body for Athletics in the United States including Track and Field, Long Distance Running and Race Walking for men and women and boys and girls at all age levels.

WN

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26 June 1990

Validation Report - Battelle Park

This is a report of the IAAF validation of the 5 kilometre road race course in Battelle Park, Battelle Stadt, West Germany, site of the 1990 IAAF Mens and Womens 5K Road Race Championships.

I flew to Battelle Stadt Flughaven on 15 June where I was met by Frau Joan Riegel, wife of Herr Peter Riegel, the race director of both events. She escorted me to the Battelle Stadt Hilton, where I met Herr Riegel, Helmut Hesser (the course manager), and other race staff members, and attended a short meeting to plan the validation measurement for the next morning. That evening Helmut and I reviewed a videotape of the mens race held earlier in the day. The womens event was scheduled for Sunday 17 June, allowing us to conduct the validation on Saturday.

Early on Saturday Herr Riegel and I drove to Battelle Park, a huge corporate park in a rural setting of forest, fields, and lakes. The area has a network of flat, traffic free, smoothly paved roads on which the races were held. The start/finish was a common point located on an entrance drive to a recreational complex. The race course consisted mainly of two out/back sections, one of which had a turnaround point created with a nail and paint on the road surface. The calibration course, located on the race course, consisted of two parallel 300 meter courses laid the year before by a team of US, British, and Canadian measurement experts. Since I was present at the seminar the year before and was the team leader for the laying of one of the calibration courses, it was not deemed necessary to check the calibration course lengths. A copy of my report on the calibration course tapings is included.

When we arrived at the start/finish area Herr Riegel discovered a short section of race course in the first mile had been torn up for culvert repairs and was rendered impassable by bike or auto. Herr Riegel was assured by the construction supervisor that the repairs would be complete by the following morning. It was necessary to steel tape the construction zone, taking care to align the tape with the projected path of the runners who would cross the zone twice. The figures of 10.97 and 10.91 metres shown in the calculations represent the construction zone lengths.

There were three locked auto barrier gates on the course. The park security supervisor could not be convinced by Herr Riegel to leave the gates open during the validation. Two of the gates could be negotiated by tilting the bike and rolling under the bar. The

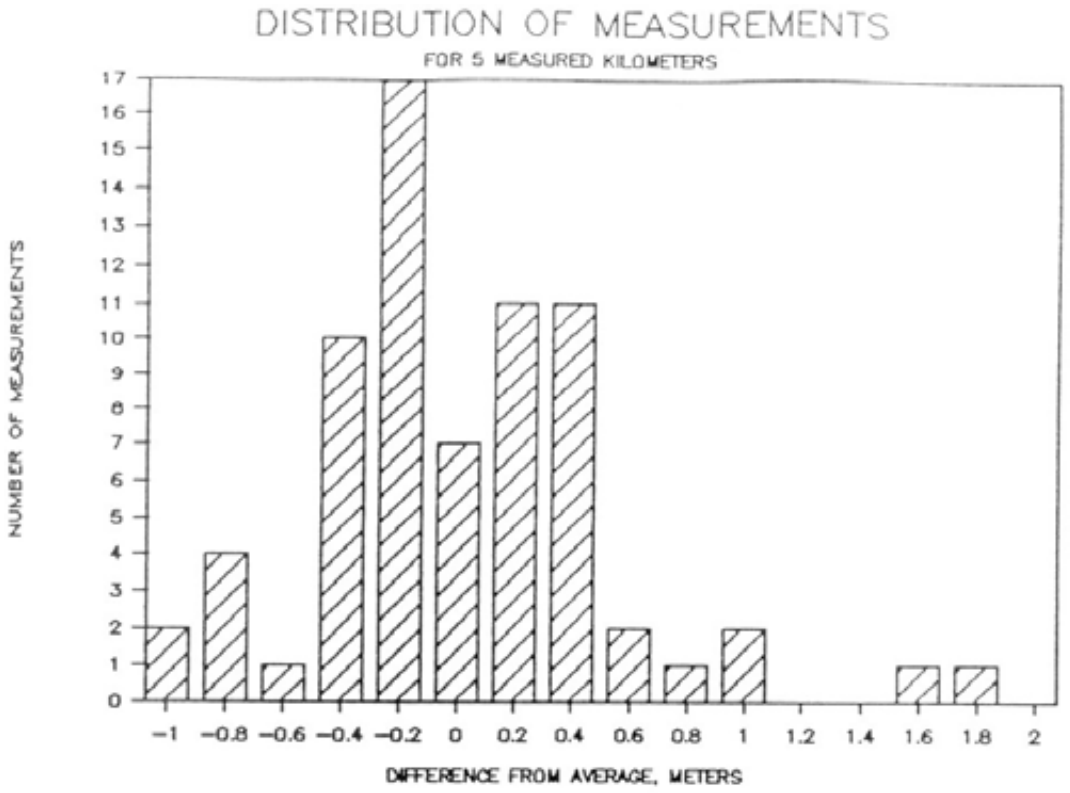
other required carrying the bike around the gate, both outbound and inbound on the course. The figures of 2.03 and 1.7 metres represent the taped distances between the stop and start locations of the front bike wheel. (used some old marks on the first pass, made my own marks on the second pass). In retrospect, it would have been much simpler to have taped even metre distances for both obstacles, i.e., 15 metres for the construction, and 3 metres for the gate.

Herr Riegel was concerned the splits might not be accurately located, since he had just learned they were not laid during the original measurement but had been laid later using an auto odometer. He asked that I check the split locations and move them if necessary. The bike calibration and recalibrations were carried out without difficulty. A slight rise in counts on recalibration is probably due to fatigue caused by the unusually hot and humid conditions of the day. I measured the course and found the distance to be 5023.2 metres, which will support any national or world records set at either event. The kilometre splits were each too long at varying lengths and the one mile split was short. The course length was shortened to 5005 metres by moving the turnaround point back toward the start/finish and each of the splits were adjusted to the appropriate mile or kilometre distance with the SCPF included. Herr Riegel seemed pleased with the adjustments. A copy of the revised course map and the calculations are included.

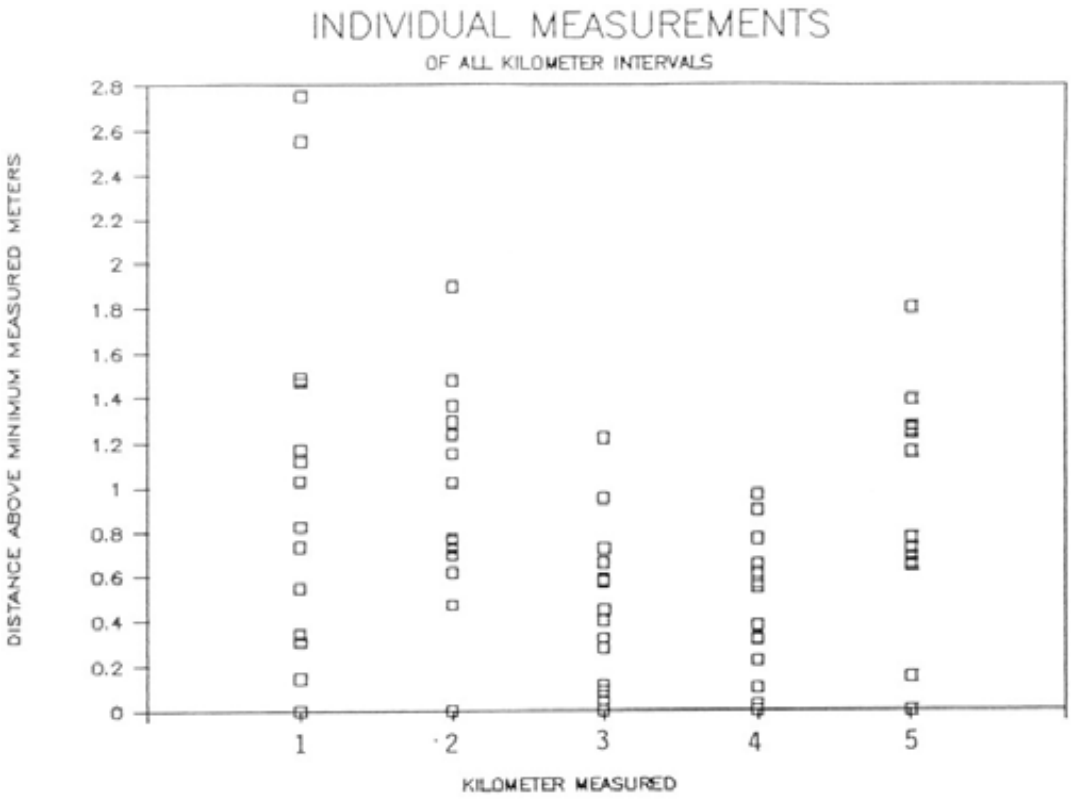
Due to another pressing commitment, I was unable to stay for the womens race on Sunday but Helmut Hesser assured me a videotape of the race would be available if needed to support any records. I am most appreciative of the splendid cooperation and warm hospitality shown by Herr Riegel, Frau Riegel, and the race staff, contributing to a smooth and successful validation.

Respectfully submitted

Wayne B. Nicoll
IAAF Validator, (USA)



Here is how the 70 measurements of five individual kilometers by 14 riders break down. It is seen that the distribution is one-sided, toward longer measurements. This is consistent with common sense, since one cannot measure significantly shorter than the legal course without leaving it. On the other hand, swerving and measuring wide on corners can produce a higher value for a measurement.

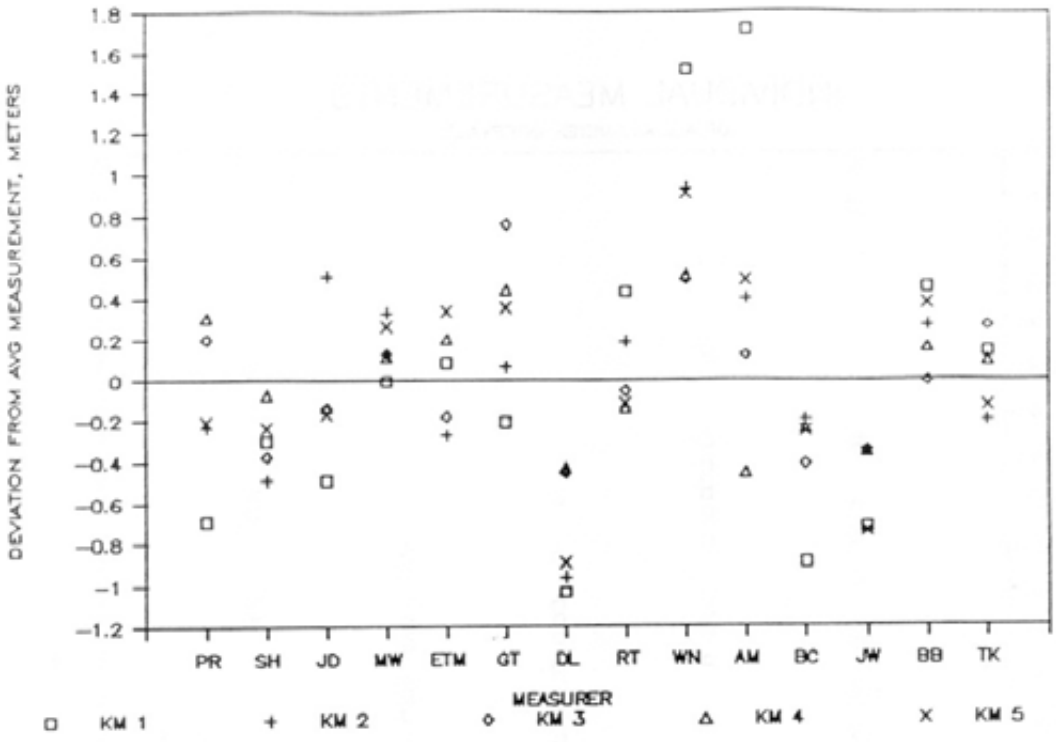


This graph shows the measurement spread on each individual kilometer of the course. The lowest measured interval for each kilometer was taken as zero.

For example, the lowest measurement of km 2 was Loeffler's 1002.6 meters. The highest was Nicoll's 1004.5. The difference is 1.9 meters. This is the highest point in the distribution for the km 2 length. All other values fell between these extremes as shown.

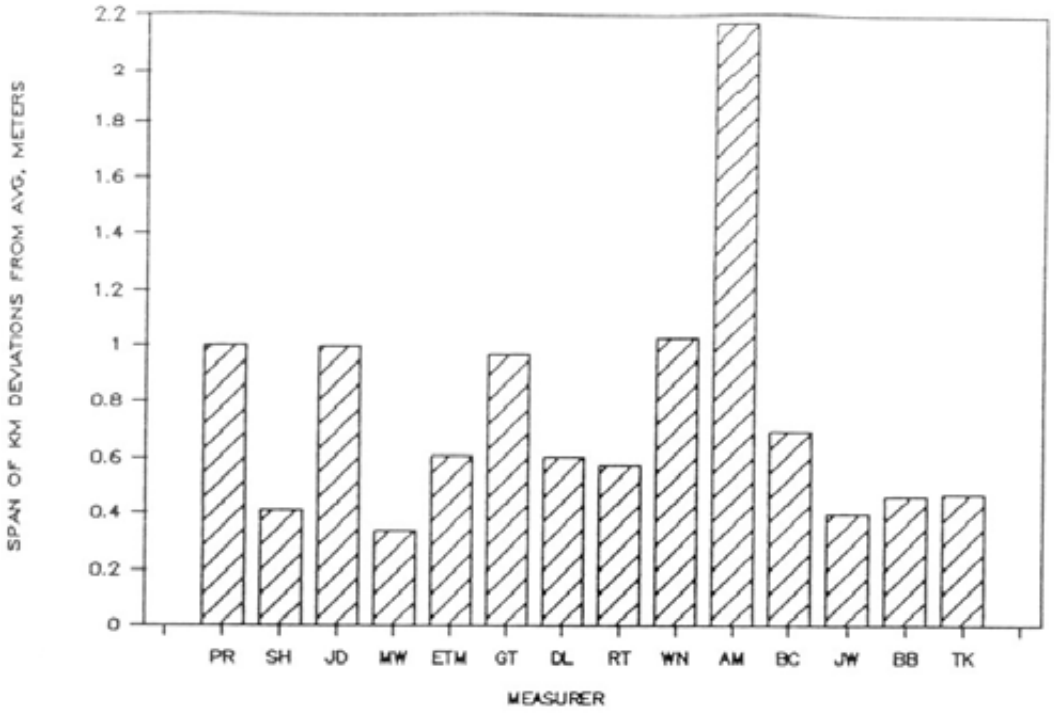
Since each "kilometer" of the course was only slightly different from 1 km, the above results show differences in m/km.

Note that those intervals with the widest variation are those that have the greatest amount of curvature. The first and second kilometers have many curves, while the third and fourth have few.



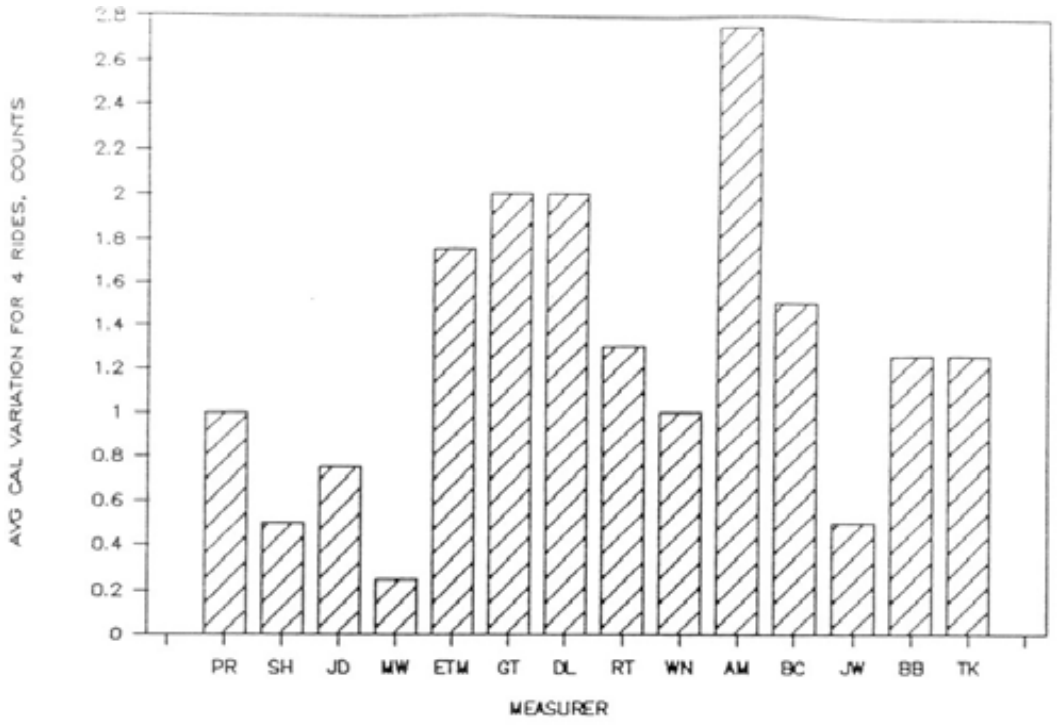
Here is how each measurer's value for each kilometer compared with the average. For example, on km 1 , Pete Riegel's measurement was 0.619 meters below the average measured value. On km 4 Pete was 0.310 meters above the average. All others were calculated the same way.

Consistency and precision of measurement is related to the span of the points for each measurer. The narrower the span, the more precise the measurement.

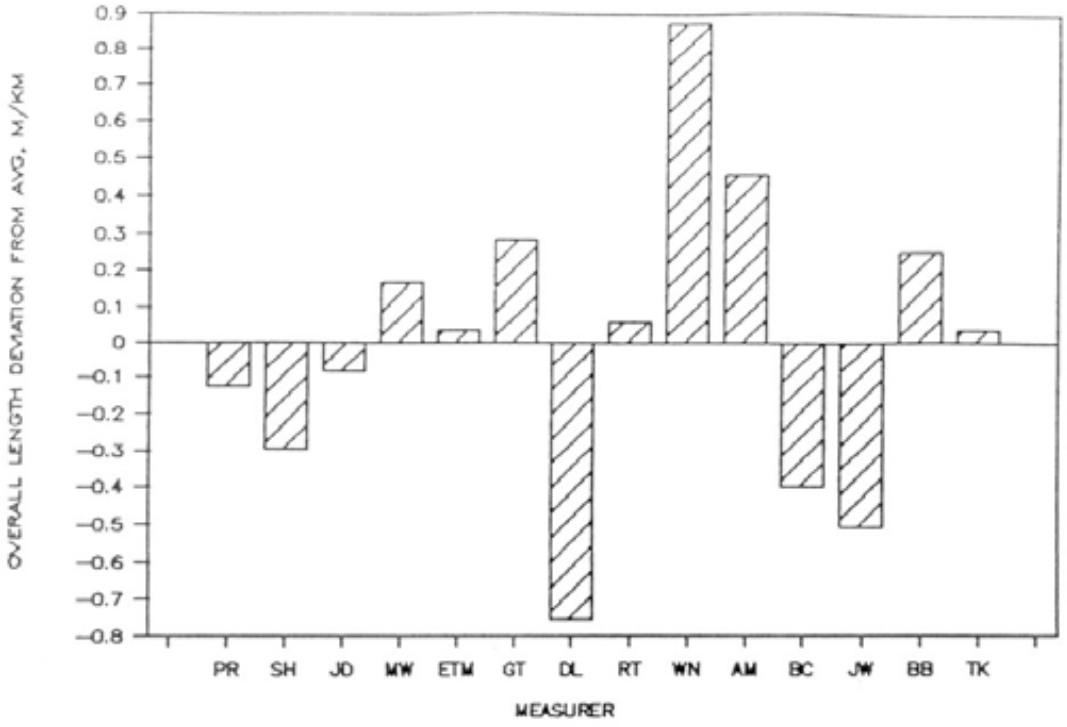


Every measurer measured five individual kilometers. On each, his measurement differed from the average by some value. The maximum span of these differences is shown in this graph. For example, on km 1 [illegible], Pete Riegel's measurement was 0.689 meters below the average measured value. On km [illegible]4 Pete was 0.310 meters above the average. His span for the five intervals was thus .689 + .310 = .999 meters. All other values were calculated in the same way.

The best riding will produce the least span.



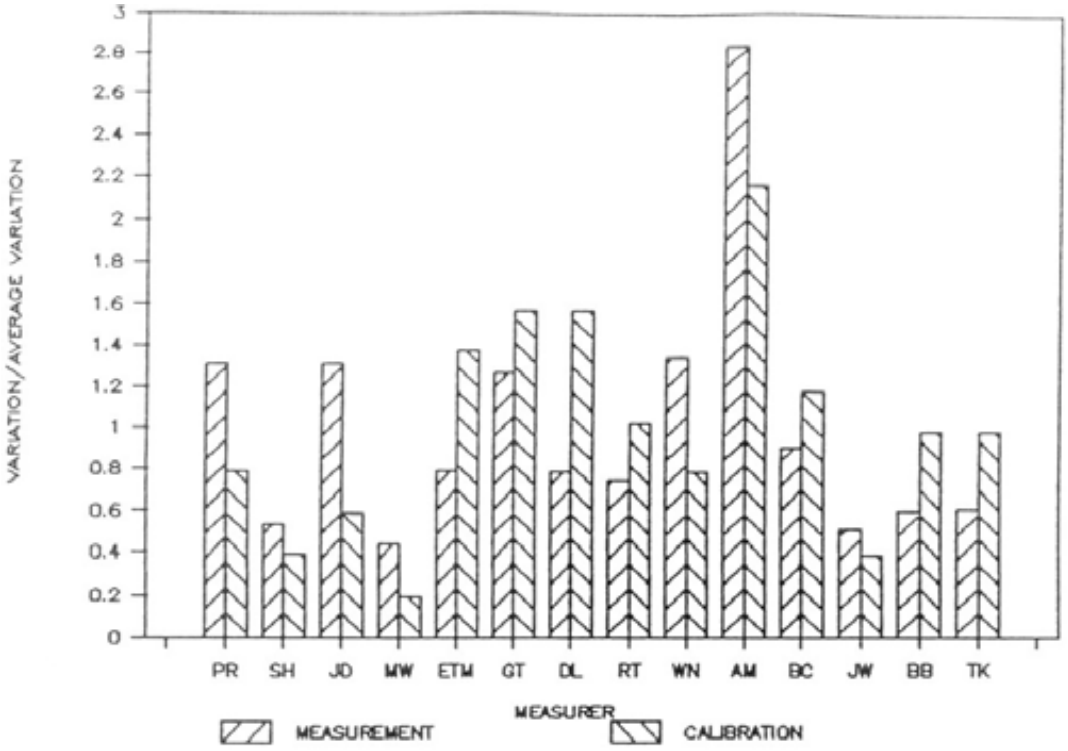
This shows how calibration varied. For example, John Disley had precalibration rides of 2778.5, 2778, 2778.5, 2779, for a precal span of 1 count. On postcal he had 2779, 2778.5, 2778.5, 2778.5 for a span of 0.5. His average was thus (1 + .5)/2 = 0.75.



Here is how the 14 individual measurements of the entire course compared with the average measured value of 5018.93 meters. For example, George Tillson obtained a length of 5020.34 meters. His length is 1.409 meters higher than the average. Since the course was 5 km long, his deviation was 1.409/5 = 0.28. All other values were obtained in a similar way.

Note that all values are less than 1 m/km from the average. This reinforces the belief that bicycle measurement has an accuracy of better than 1 m/km.

In an exercise to ride the exact route as accurately as possible, the best riding will produce the least deviation from the average, assuming that the course length is indeed represented by the average.



Do we measure as we calibrate? Is there a relationship between calibration variation and measurement variation? Here we see each measurer's calibration variation shown next to his measurement variation, for the five measured intervals. It appears that, in general, steady calibrators produce steady measurements.

For example, Mike Wickiser had an average calibration variation of 0.25 counts. The average variation of all measurers was 1.27 counts. Mike's calibration ratio was .25/1.27 = 0.20. Mike's measurement variation over the 5 intervals was 0.339, while the average was .765. His measurement ratio was thus .339/.765 = .44. All others were calculated the same way.

COMMENTARY ON THE RESULTS

Before launching into the benefits and deficiencies, it should first be made clear that almost everybody produced the correct answers in their reports. The test was a stringent one, in spite of its apparent simplicity. I hope that participants will study their methods, and work to improve them where they fall short. After all, in a real situation of this kind you could well face the same exercise, only it won't be a test. It will be the real thing, and you'll be judged by your work.

Observed Benefits

1) All measurers rode within reasonable limits, given the nature of the test course. Riding skill was thus seen to be reasonably good.

2) All measurers reached the proper conclusions, based on the data each obtained. Calculation skill was apparent, and on-site conclusions contained few errors.

3) Maps were adequate to define the measured course.

4) Narrative accounts varied, but were generally acceptable.

Observed Deficiencies

1) Premature or incorrect rounding-off of calibration values. Retain at least 6 significant figures in calculations, and do not round off until the final answer is reached.

2) Using "counts" as a unit of measurement. Several measurers converted their taped distances into counts, and rolled the front wheel until a new count was reached. This is inexact, since the proper number of counts is unknown, since recalibration has not yet been performed. Generally only a small error is involved, but it can be a big one if taped distances are large.

Recommended approach: When checking an existing course, forget you have a calculator. Calibrate, measure the course, stopping at all points and recording counts, and recalibrate. Tape between points you cannot ride between, recording the both the points and the taped distance between them. Then convert everything to meters (or miles or whatever you're working in). Once you have done that you are done with counts, and should not think of them again. All adjustments can be easily figured by using the measured lengths of the intervals.

Some measurers carried the "count" approach to extremes, treating them as though they were as valid as meters. A count is merely a tool we use to find out a distance. It is not itself a distance.

There is nothing inherently wrong with using counts in your own figuring. However, the presentation to others who may have to follow your work is greatly clarified if distances are converted to meters at the earliest opportunity.

3) Did not record a count at either side of the construction area. In general this was done by those who thought in "counts." On the whole, few were very clear just exactly how they measured across the construction zones.

4) Premature calculation. In a validation involving already-established split points, first measure the course as it is. Do not get involved in trying to figure out where everything ought to be as you ride. You do not know this anyway, since, until you recalibrate, you do not know your correct constant. Once you have all the data in the bag, then get out the calculator and figure out what you have and how things ought to be. If you stopped at all the splits, you will have enough information to adjust them later. This is not a job that needs to be done as the ride proceeds.

5) Using feet and inches as reference dimensions. IAAF and almost all of its member federations use the metric system. The US is practically alone in the world in its adherence to the Imperial system.

6) Landmarks on map shown on the wrong side of the road.

7) Adjusted turnaround shown on the map with adjustment made in wrong direction.

8) Use of improper constant in figuring distance. IAAF uses the average constant, not the precalibration constant or the larger constant.

9) Closed gates: Few reported how they negotiated closed gates. One report made no mention of gates or construction areas at all, instead reporting the measurement as though it was an uninterrupted ride. Lack of this information makes it difficult or impossible to trace exactly what was done by the measurer.

10) Inaccurate documentation of reference points. It is impossible to know how another group would have performed, since we are the only ones to do this, but it appears that our reference point documentation could use work.

Pete

HELP WANTED

Does anyone use softwear for drawing maps on a Mac SE?

Please send info to Joan Riegel - We'd like to use this at the Columbus Marathon office.

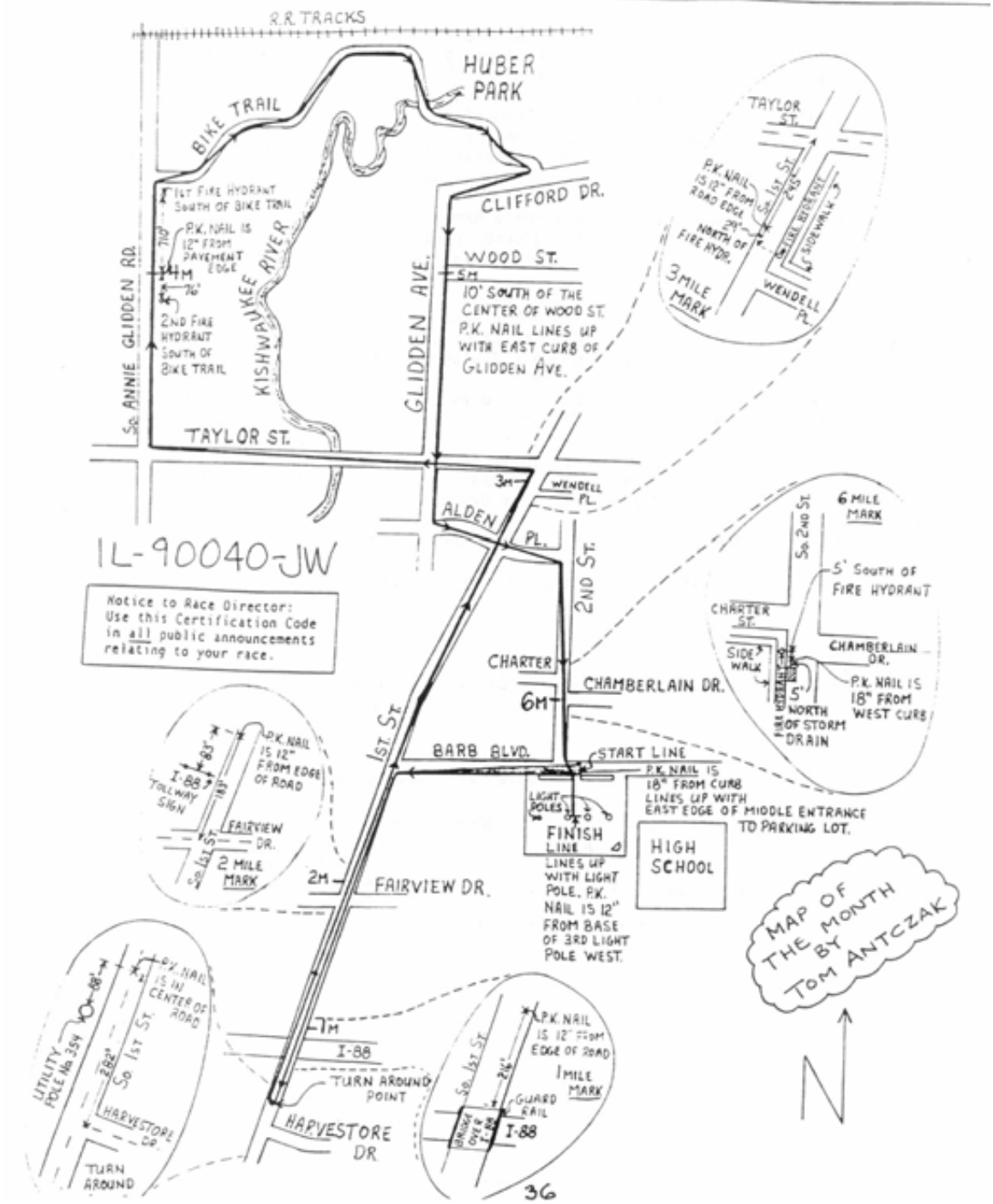
Many thanks.

Joan

DEKALB CORNFEST 10K

DEKALB, ILLINOIS

MAP NOT TO SCALE



THE ATHLETICS CONGRESS
OF THE USA

3354 Kirkham Road
Columbus, OH 43221

Road Running Technical Committee
Peter S. Riegel, Chairman

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August 10, 1990

Joe Stallings - 3417 Ute Rd - St. George, UT 84770

Dear Joe,

I enjoyed our talk last evening. I sensed a kindred spirit. Here are copies of recent issues of Measurement News. Enjoy it, and subscribe if it strikes a chord of interest.

I'm enthusiastic at the prospect of working with bikers to establish measurement standards for your sport. The standards you described to me seem over-tight, and not really attained in practice. Although it is possible to measure to 1/10000 accuracy, the presence of crumbled road edges, storm drains, and ill-defined corners makes any such measurements meaningless, for practical use.

I have seen surveyor-measured race courses, and most of them fall down because the surveyor very carefully measures some line, but it is not the line he was supposed to measure. Generally surveyors do not have the concept of shortest possible route in their minds, and they use some other approach. This results in short courses, expensively measured.

The Japanese used to use a crew of 25 people with a long steel tape to measure their marathon courses, feeling that this led to greater accuracy. It did. but it was time-consuming and expensive. By conducting seminars with them, we have converted them to the bike method. The International Amateur Athletic Federation has also adopted the TAC bike method for road race course measurement around the world.

The key is defining exactly what is to be measured, and then measuring it. That's why we have zeroed in on the concept of shortest possible route. Given that bikes will follow a more legal path than runners, it seems to me that it would be easy to define a different standard for use in cycling events.

I'll be happy to help in any way I can. As I mentioned, it may be possible for your organization to piggyback onto our certification process. We have a measurement bureaucracy that works and is in place. Of course, there's no reason why you could not establish your own setup. Either way you choose to go, let me know if you want help.

For the time being, there's no reason why you can't simply get cycling courses TAC certified. The process is simple and easy, and will give you an official certificate to display to show that a recognized standard has been met in the course measurement.

Please get in touch if you have further questions.

Best regards,

THE ZOO PUZZLE

I need to find another line of work. I thought the Zoo Run map was practically perfect, but found out differently. I stand humiliated and corrected. Get out your July MN (the zoo map) to follow this:

Bernie Conway won the Milkmaid Mini-Walk '89 t-shirt, sponsored by the Malay Mail. He correctly pointed out that my description of the finish ("on the west side of the amphitheatre") conflicted with the finish diagram, which showed it correctly, on the east side. Tom McBrayer, Bill Glauz, and Eric Smith also found the mistake, but after Bernie.

Tadeusz Dziekonski found another mistake. On Riverside Drive I said "right lane only," since that's the right lane as one drives north, and as one looks at the map. However, the race runs south on Riverside Drive. I should have said "left lane only." The diagram makes it clear, but the text could be misinterpreted.

David Reik pointed out both the mislocation of the amphitheatre and the "right side only" mistake. He also mentioned that I neglected to say "cones and monitors required."

Tadeusz also mentioned that I marked the 1 mile split on the south side of the road, when the runners actually encounter that split after rounding the turn. Thus its natural position would be on the north side of the road. I marked the 1 and 3 mile splits as I rode to the turn, on the south side, and marked them there, thinking that the race director would simply put the race-day mark where it belonged. I also showed them where they belonged on the list of splits. I will try to do better in future.

Bill and Eric also mentioned my slip of the pen as the runners passed through the underpass, and the line deviated from the SPR. To this I plead artistic license.

Tom said that in America we spell it "amphitheater," not "amphitheatre," also mentioning that there was a discontinuity in the SPR line from Powell Road to the zoo entrance. Artistic license again.

Eric noticed I had not said where cones and monitors should be placed. On this, my philosophy is that if a cone is absolutely required to define the course, I show it on the map and describe its position. Otherwise, I consider it the race director's job to do whatever it takes to keep runners on course. Eric also pointed out that my turnaround mark was at the side of the road, where the normal position for a TA cone is in the middle of the road. True, but marks last longer at the side, and most race directors will put the cone in the middle, opposite the mark.

August 23, 1990

Dear Peter Riegel:

Thanks for putting forth a puzzle that doesn't involve incomprehensible mathematical symbols.

It looks like the zoo path where the race finishes is actually on the east side of the amphitheater, not on the west side as the "List of Measured Points" states. Or maybe the map is wrong, but that seems less likely.

Actually, I think the more substantive deficiency is the map's failure to obey this dictum from the revised Course Measurement Procedures:

> "If your measured path was not always the shortest possible route that a runner could run using **any** part of the street or road, then traffic barricades or cones must be set up to insure the runners cover at least the distance that you measured. Your course map must indicate **exactly** where such barriers are to be placed and also show where monitors are to be stationed. If this seems like too much trouble, just measure the shortest route assuming no barricades and you'll be safe." (page 26)

Along Riverside Dr., you have the runners restricted to the eastern-most lane, which you call the "right lane", which it is for the cars, although it is the left-most lane for the runners. If we didn't like this requirement, we should have gotten rid of it when the book was revised.

About the Guido Bros. altimeter. Although it may be fine for course profiles, it doesn't seem to be exact or accurate enough to be used to determine if a course meets our "no more than 1m drop per 1000m of length" requirement. For the recently certified Corporate 5K in Hartford CT, as best the Guido Bros. could figure from their altimeter, there was only a five-foot difference between the start and finish. According to my 1" = 200' map, which has a contour line for each 2' change in elevation, there was a 16' difference-- just barely within the limit. I sent a copy of my map to the Guido Bros. and they concurred with my reading of the map. I suppose, in important cases close to the limit, either for separation or for drop, we might want to have the difference between the start and finish surveyed-- that's the sort of stuff I think surveyors excel at. We don't even actually need absolute altitude numbers, just the difference between the start and the finish, horizontally and vertically.

I love my "measurement News". Retaining my subscription is a major motivation for continuing to do my certifier duties.

Sincerely yours,

David Reik

David Reik, 930 W. Blvd, Hartford, CT 06105 (203) 236-9160

THE ATHLETICS CONGRESS
OF THE USA

3354 Kirkham Road
Columbus, OH 43221

Road Running Technical Committee
Peter S. Riegel, Chairman

614-451-5617 (home)
614-424-4009 (office)
FAX 614-424-5263

August 27, 1990

David Reik - 930 W. Blvd - Hartford, CT 06105

Dear David,

Bullseye on your puzzle solution. Unfortunately for you, Bernie Conway got the mislocation of the amphitheatre first, and got the t-shirt. Tadeusz Dziekonski also identified, as you did, that "left lane only" would be correct for Riverside Drive, because the runners are heading south, not north.

As for the cones and monitors, I am ill at ease with that requirement in the book. I believe we must specify all locations where a cone defines a turn, but in areas such as "right lane only" it seems a bit like hectoring the race director to tell him he must do this or that.

The map is supposed to be a clear statement of the measured, legal course. How the race director chooses to guide the runners ought to be outside the scope of our maps, in my view. However, you are right in that the book says we are suppposed to do it. I would have struck out that passage when revising if I had noticed it, and hoped that there would be no objections.

If I had received my zoo map from another measurer for review I'd have thought it was a pretty decent map, and I doubt I'd have bounced it.

I'll put your letter in next MN to see what views the readers have on it. Maybe we will change policy at the convention - maybe not.

On trying to split hairs on elevations - I'd hate to have to have a survey done to detect the fine line. Maybe it would be better to give the course the benefit of the doubt in gray areas. It's not something we have yet had to deal with, but there is surely an area of uncertainty here.

The Corporate 5k certainly had some fancy maps available. 1"=200' with 2 foot contours is rare to find. I have a few of them, but they are related to work, and I have never had anything so precise in an area of a race course.

Rick Recker was the measurer who finally accepted the last-minute invitation to go to Mexico City. When I called him Friday noon he had contacted the Mexicans and was still waiting for final arrangements of his ticket. I have to go to Minneapolis on business on August 28, and will have dinner with him, and listen to his war stories. Loeffler did a similar measurement last year it was a very confused affair.

Best regards,

Pete

275 Main St. Ext.
Freeville, NY 13068
July 19, 1990

Dear Pete,

With the added hint that I'm supposed to be looking for something a little grosser in the error category on the zoo map puzzle, I've come to the conclusion that you are very likely thinking that in the finish description it would have been better to have described the zoo path as being on the southeast side of the amphitheater rather than on the west side.

In a related vein, I am now wondering why you ended up marking the 1 mile point on the south side of the road with nail and washer, as it would seem more natural to put it on the side where the actual number would be painted, and where you would most likely have been riding with your bicycle looking at the Jones counter and waiting for the right number to come up.

In regard to my earlier observation about the line drawn in for the SPR, it seems that the principal reason for drawing in the actual shortest path line as accurately as possible is to demonstrate to the regional certifier that the course measurer really understands the principles involved in choosing the shortest route around corners and bends, or simply hasn't had a mental lapse and picked something other than the shortest path. Otherwise, the line of the race might as well be drawn in the middle of the road. Clearly in your special case where you are both the measurer and certifier, and know perfectly well what you did and thought, there is no problem. However, if I had drawn an SPR that looked suspicious at a turn or a bend and submitted it after a course measurement, I suspect it is quite likely that I would receive a phone call a couple of days later from Amy Morss asking me if I really had taken that line during my measurement!

Actually, my main reason for writing is not to verify that I am capable of proofreading (if given enough tries), but to add an alternative suggestion to a way of dealing with some of the problems which the short-course-prevention-factor tries to address. Although I am sure that my suggested approach would be controversial, I think that it is a fresh approach to an inadequately solved problem, and worthwhile for the readers of Measurement News to think about. I should perhaps comment that I have had a relatively long-standing interest in the measurement of running courses, having first measured a couple of marathon courses for our club using the calibrated bicycle method about 20 years ago, back when the AAU rather than TAC was the governing body. Subsequently I laid out several other courses for the club, but never bothered with certification, as I was mostly interested in having accurately measured courses and not much worried about the bureaucratic or administrative aspects of running. However in the last couple of years, various club members decided it was desirable to get our various actively used courses certified, and I was 'volunteered' for the job. At the same time, after reading the current booklet on course measurement, it seemed desirable to have the club subscribe to Measurement News to keep abreast of current thoughts and developments in this area, and I have found the several issues which we

have received to be quite interesting reading. Professionally I am an experimental physicist and devote a lot of my efforts to making and interpreting precision measurements, so that although I have only recently been developing an interest in the philosophical aspects of course measurement, I do have some background preparation.

There seem to be two basic interests served by accurate measurement of courses. One is for the information of average runners who are interested in how far and fast they run, and the other is the keeping of records of the fastest times run by runners, often broken down into rather small categories of age, sex and possibly geographical origins of the runner. It seems to be particularly this latter category of functionality with which the TAC is concerned, even though far fewer runners are ever involved. This is quite reasonable, as the accuracy requirements are probably more stringent, so the first function won't suffer as a consequence. The problem, however, is that it is much easier to measure time accurately than it is to measure distance. Thus, even though it is seen in the various discussions by such people as Bob Baumel and Alan Jones that factors such as wind, net elevation changes, and 'steepness integral' can have much larger effects than the roughly 0.1% accuracy which the calibrated bicycle seems to be able to achieve in the hands of a moderately skilled practitioner, it is clear that the time can be measured to .01% with ease over the length of a marathon (i.e. nearly a second), or even on a 10K course with a little more effort, and record-keepers aren't satisfied with a +/- 0.1% accuracy measurement on a course. In particular, people are (irrationally, I feel), much more concerned with the -0.1% end of the error, and the short-course-prevention-factor (SCPF) has been incorporated to make sure that any course is likely to be found at least long enough upon a subsequent measurement by a different measurer. This is a fine concept, if one keeps records which exclude any race which is found to be short by any amount, no matter how small, even if less than the uncertainty in the measurement. However, it really doesn't address the fact that there is going to be a spread of typically up to 0.2% in length between courses measured by reasonably competent measurers. In my opinion, it is just as bad for a person running a record pace to lose out on a record because the course was an extra 0.1% too long, and hence the time a couple of seconds above the record, as it is for someone to have the record taken away because a validation measurement comes up 0.01% too short.

How do we address this issue? I would contend that we need to use a different, higher accuracy validation measurement on courses upon which records are set (or in advance on major courses where records are likely to be set, such as for Olympics marathons or large prize money events, where there is likely to be more money available for the measurement in any case), and use a linear time correction to adjust for any error up to 0.3% (or whatever would correspond to about 3 standard deviations in measurement accuracy) in the original measurement. A correction would be automatic for any time under or within 0.3% above the record. This correction would be so small that it would certainly not be giving any particular advantage to someone running either a slightly short or slightly long course. Because validations are required much less frequently than original certifications, it is reasonable to devote more time, effort, and expense to the validation process than to the basic measurement. Some judgment might need to be excercised as to how important a record would require validation to high

precision--perhaps a record for 11K by a 57 year old male could be served by a repeat bicycle measurement coming within +/-0.2% of the correct distance.

My thought would be that the validation measurement would best be made by the use predominantly of EDM, which on reasonably long sightings could give actually rather better than .01% accuracy, and which could be used on all straight segments of courses, and on the insides of curves. This should account for the vast majority of the distance on most courses (more than 90% on those which I have been involved in measuring), and means that the remaining distance going around the outside of curves can be measured with the lesser accuracy achievable with either steel tape or calibrated bicycle, and still stay within the limits of .01% which might reasonably be set as a goal for measurement accuracy for the total course.

I would be inclined to drop the SCPF altogether if such a higher accuracy validation scheme were to be adopted. My feeling at the moment is that all it really does is to redefine the meter to a new distance. Various standards organizations have gone to great lengths to define it accurately and precisely, and it seems a pity to intentionally ignore their efforts. The SCPF does nothing to correct for the inherent differences between courses measured with a method yielding an uncertainty on the order of the SCPF. Whereas this uncertainty is probably irrelevant for the average runner, who is almost certainly not capable of sensing his running pace to 1/4 second per kilometer anyway, for record-keeping purposes it might be worth the added effort to do a more elaborate validation and correct the times appropriately.

If you feel that these opinions would be of any interest to the Measurement News readership, feel free to photocopy any of the above for inclusion, or to summarize it yourself, or to ask for a more coherent rewrite, or to communicate any modifications or conceptual changes which you yourself think should be made in the general line of thought. I suppose that with a little extra effort I could ship my text into work and produce a slightly more legible copy on a laser printer, send you a copy of the text on a floppy disk, or send you the text by e-mail if you happen to have access to a computer hooked up to internet or bitnet. I realize that adjusting a finish time to make it a record is a somewhat unusual concept, but already road-running records are kept separately from the more standardized track records, and I don't see why a different book-keeping standard couldn't be applied.

Yours sincerely,

Eric Smith

Eric Smith

THE ATHLETICS CONGRESS
OF THE USA

Road Running Technical Committee
Peter S. Riegel, Chairman

3354 Kirkham Road
Columbus, OH 43221
614-451-5617 (home)
614-424-4009 (office)

July 24, 1990

Eric Smith - 275 Main St Ext - Freeville, NY 13068

Dear Eric,

Jackpot! But Bernie Conway beat you to it. The written description of the finish conflicts with the sketch, which is accurate. I seem to get left and right, east and west, north and south mixed up from time to time, although I know about it now and watch for it.

I marked the points on the south side because that's where I was when I laid them out. I can see it would be a bit better to put it on the other side.

Maps need not show a full-width road at all, if it is noted that SPR is everywhere followed. The full-width depiction does help the certifier dope out the route that was measured, but few maps have this drawn perfectly. It's usually done just to give the general idea. I routinely get many lousy maps, and if the answer to question #23 is "yes", I assume they measured the SPR as they said they did. In general, SPR is assumed unless they say it is not.

I am sure we have a fair number of marginally short courses, but equally sure they are not short enough to matter, except when the record-validation process comes along. We put a lot of work and emphasis on the records part of our work, even though that part is a tiny fraction of the sport. By doing this we get a spillover of benefit, since folks see we are paying attention, and this makes them careful. As a result, the average courses are now a lot better than they used to be. This benefits the ordinary runners, which ought to be our goal.

As you may have noticed from the validation summary which appeared in a recent MN, we have about 90 percent success in our validations, and few remeasured courses come up very short. This tells me the system is working pretty well. If we strove for 100 percent, I'm afraid we would have to lay out courses way too long.

Nobody will lose a record because the course is 0.1 percent "too long." If all courses are measured the same way, the extra 0.1 percent is simply standard. We have addressed the issue of measurement error in validations, to the extent that we will accept a 10k as OK if it remeasures more than 9995 meters, and other distances proportionally. This allows for measurement error. This was put in place because if we do have to shoot down a fine effort, we at least don't have to defend our saying that a marathon that remeasures at 42193 meters was "shown to be short." Where we have drawn the line pretty well puts things beyond reasonable doubt.

It would be just as easy to lay out courses at the exact distance, and shoot them down if they remeasure 0.1 percent short. The net effect is exactly the same. There must be a gap between layout and validation that approximates a reasonable amount of measurement error.

As for adjusting times for marginally short courses, that's something for the records-keepers to decide. Personally, as long as the system is even-handed and treats everybody alike, I don't see where beefs may arise from. There may be better ways to do things, but each change affects the things around it, and a simple change can have complicated consequences.

Because we have a lot of validations to do, I'd not recommend that anybody use EDM. It's accurate on the long straightaways, but then so are bikes. It's on the turns that the errors are made, and EDM is no help here. In addition, we get into crumbly road edges, storm drains (measure across or around?) and other things that require on-the-spot judgment. To get reproducible high-order accuracy we would have to insist on very clean, well-defined road edges everywhere, and this doesn't always exist on our roads.

A validation cannot be more than a competently-performed measurement, or it will take more time than the validator may have.

I guess I am saying that our measurement procedures are not perfect, but represent a compromise between accuracy and available time. If we insist on more accurate measurement methods, we may wind up with fewer courses being measured, and that's a bad thing. Personally, I don't think that the amount of error we have right now is objectionable.

Because time can be measured with better accuracy than distance, we have the consequence that people will say that 5 meters of measurement error is equal to a second, or some such, and isn't it a shame that somebody can be deprived of a record. Maybe it is, but I know of no better way than to set up a standard procedure, follow it, and accept the consequences.

Our system has evolved over time, and now we have hundreds of people measuring courses in the same way. Our instructions have been the same for over six years now, and the word has gotten around how things are done. Any proposed changes need to address whether we would have to basically start over with a new measurement book, and a re-education process of the entire nation - and the world too, since IAAF does things as we do now.

What we have is imperfect, and we know it. It's the best we have been able to do, given the resources at hand. On the whole I think it does pretty well at the job.

Because you seem interested in measurement variation, here's a copy of the proceedings of our recent International Measurement Symposium. You would have enjoyed it. Maybe next time.

Best regards,

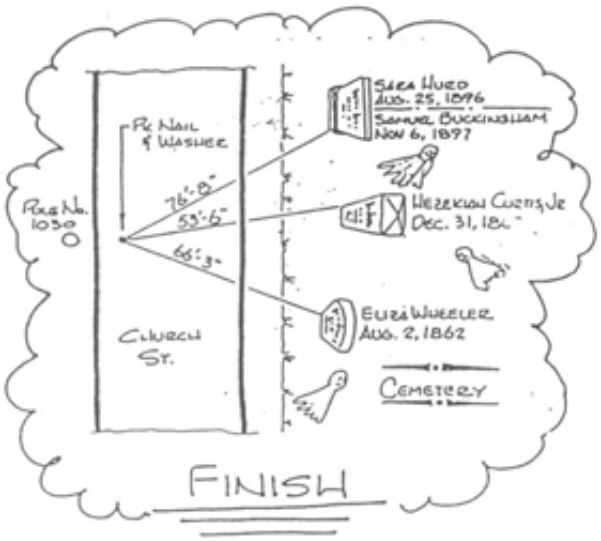
ARTISTIC MISCELLANY

OVERWORKED MUSE INSPIRING TWO ARTISTS?

FROM JOAN RIEGEL

24 de setembro de 1989
Rio de Janeiro — Brasil

Sunday, September 23
Albuquerque, NM



Pete -
Note the finish diagram
Wayne

FROM WAYNE NICOLL

CT 90009 DR MEASURED AND MAPPED BY GUIDO BROS.

The Athletics Congress of the USA

Road Running Technical Committee
Bob Baumel, Vice-Chairman West

129 Warwick Road
Ponca City, OK 74601
405-765-0050 (home)
405-767-5792 (work)

1990-08-15

Dave Poppers
5938 S. Franklin St.
Littleton, CO 80121

Dear Dave,

You had to be pretty sharp-eyed to catch the incorrect listing of Drop for the "20-Mile Road" Cal Course (CO 87006 TK). Of course, you are right: it should be zero instead of the listed 8 m/km. As you noted, the certificate was an old one that didn't explicitly list the Drop and Sep. Apparently, Joan slipped up when figuring the numbers to punch into the computer. I will send Pete a note to fix the listing.

But it really makes very little difference. The great majority of (listed) cal courses are listed with grossly inaccurate Drop figures. Specifically, the Drop is almost always listed as zero, even though the cal courses aren't level. It's just that the Application for Certification of Calibration Course asks for only *one* representative elevation, which means that the information for computing Drop simply *isn't available*. Nevertheless, certifiers usually fill out the certificate with that single known elevation in all four spaces (as if the course were exactly level), and they enter zero as the Drop. (When I write a certificate for a cal course, I put the one known elevation in only *one* place, and I enter a question mark or N/A as the Drop.)

I became aware of all those cal courses with incorrect Drop=0 listings last year when I tried some computer counting of the course list (see my letter in May 89 MN, pp. 9-14). Eventually, I realized that my counts of courses with various amounts of Drop and Sep were biased by a significant number of courses with Drop=0 and Sep=100, which turned out to be cal courses (see my handwritten PPS at the bottom of page 14). Since I personally never enter the Drop on a cal course certificate unless I accurately know the elevation difference between the endpoints, it hadn't occurred to me that many other certifiers would indiscriminately enter Drop=0 on cal course certificates. So I didn't check for cal courses in my computer program that scanned the course list. Pete Riegel's course count statistics were more accurate than mine, because Pete was careful to weed out the cal courses.

Fortunately, all these inaccurate Drop listings for calibration courses are of no practical importance. Drop is only important for *race courses,* where it determines eligibility for records (cutoff at 1 m/km by Rule 185.5 as revised in Dec 1989). Drop of a cal course has no legal significance. We would, of course, worry about the drop of a cal course if it significantly reduced the accuracy of measuring race courses with it. Certainly, the accuracy is reduced when a measurer has a steeply-dipping cal course, and rides it in only *one direction.* But loss of accuracy is probably negligible when the measurer does equal numbers of rides in *both* directions, and averages them. (Thus, measurers should *always* ride their cal courses in both directions, because normally, we simply don't have any data to say whether the cal course might be steeply dipping.)

Changing the subject, you asked about calibration courses "previously certified, with apparently adequate maps, no longer shown" on the list. It is almost certainly wrong to assume that these courses were removed from the list. In all likelihood, they *never were* on the list in the first place. Pete Riegel has never taken any cal courses off the list. The courses that Pete removed due to lack of maps in early 1989 were all *race courses.* On the other hand, it's been only within the past few years that any cal courses at all have been getting listed in the national certified course list.

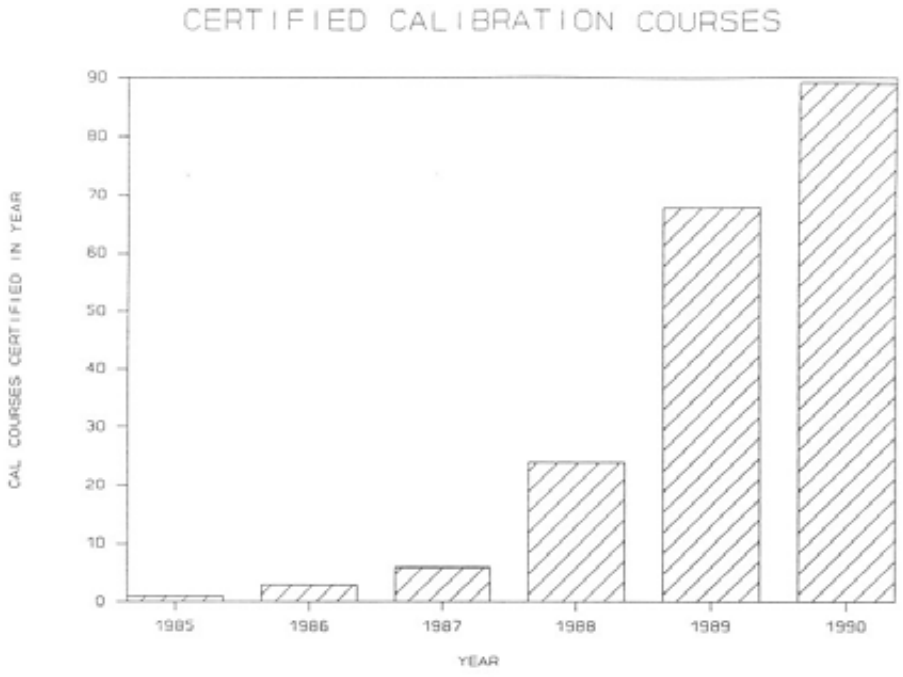
Back when NRDC kept the list, it was just a list of race courses; they *never* included any calibration courses. When Pete took over the list in early 1987, he was initially ambivalent about including cal courses. Somewhat reluctantly, he agreed to accept them. Then he noticed that some certifiers used different sorts of numbering schemes on their cal course certificates than on ordinary race course certificates. So Pete decided it was too much trouble to include cal courses on the list, and he stopped accepting them.

But by around the beginning of 1988, Pete did (quietly) begin accepting calibration courses again (assuming they followed the same standard numbering scheme that we use for race courses). Virtually, all the cal courses now on the list were therefore certified in 1988 or later. As Pete's resumption of cal course listing was not accompanied by any great fanfare, some certifiers didn't realize right away that it was OK to send in their cal courses (and perhaps some *still* haven't gotten the message).

For your reference, I have enclosed a copy of the Colorado course list, current as of July 90 MN.

Best regards,

Bob



ANNUAL COURSE LIST DISTRIBUTION TO CEASE

In the past we have distributed annual course lists to certifiers. This permits certifiers to weed out the obsolete courses from their state lists. Historically, few do this, although we are grateful to those who do. Because we are not sure whether this distribution really is effective, automatic annual distribution will cease.

Course lists have always been available to any certifier who requests one, without charge. This will continue. Therefore, any time you want a course list, you are encouraged to write for one. This will assure that you get a fresh list when you are ready to use it, not when we happen to be making an arbitrary distribution.

Entire Printed Course List - This list includes every currently certified course in every state. It will be about 140 pages this year. It will be published in November, in time for the TAC Convention. If you want a copy, send $15 to Joan Riegel before November 10. One will be sent to you by first class mail.

Dear Pete,

Thank you very much for your letter of May 2, next copy of "Measurement News" and for your greetings card from London by Henryk Piotrowski.

Last time I used the speedometer/Soviet Union's product/ and my opinion is one - not fitted for the measurements. This counter shows only evry 100 m. I will try to send you a photo.

Three weeks ago I have measured "Solidarity" Half-Marathon, which will be held August 15 from Gdańsk to Gdynia. "Solidarity" came into existence in Gdańsk. It was a hard work, because I had to made it by night and without a police protection - organizer did not secure it. Four times I was stopped by police patrol. Thanks God that I was not put under arrest. But two days later I ran aesy 2:53.59 on a hilly marathon course.

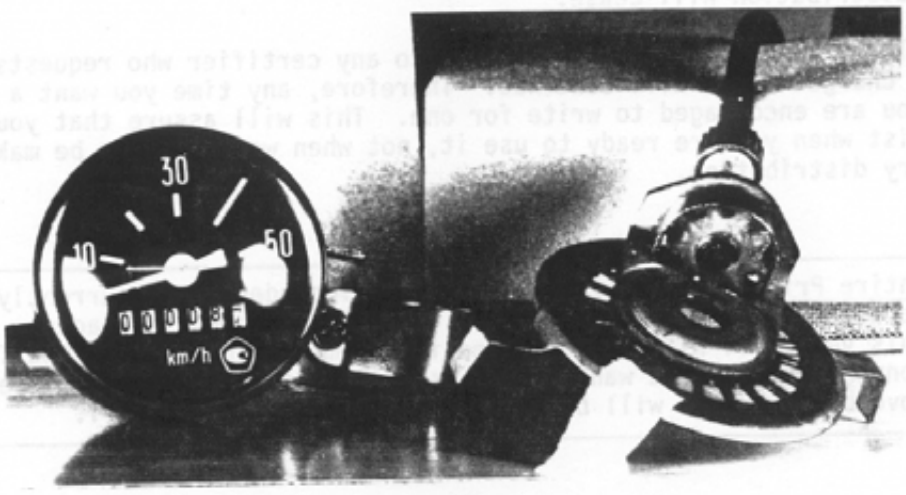
Together with Mr Helge Ibert we have measured Dębno '90 course, where since many years has been held Polish Champs. All time we worked in rainy weather. Soon Mr Ibert send us and you/and to Mr Paulin and Mr Disley/ all detailes of our work with his finel conclusion. After receiving it, I will comment our measurements. Mr Ibert was as an examiner.

Best wishes

TADEUSZ DZIERŻONSKI
ul. Chrobrego 4 m. 8
(skrytka pocztowa 141)
15-057 Białystok
POLAND

P.S.
I ran Dębno Marathon in 2:51.52.

Białystok, June 12, 1990



SPEEDOMETER (MADE IN USSR)

For replacement parts, fill out form below and send with check to:
Midway Sales, Inc. P.O. Box 16509, Columbus, Ohio 43216

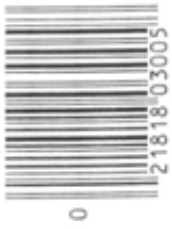
Enclosed find $_____ for parts indicated below.

20" Drive Cable	$ 3.75
26"/27" Drive Cable	$ 4.00
Drive Unit	$ 2.75
20" Speedometer Head	$ 5.75
26"/27" Speedometer Head	$ 5.75
Axle Washer & Bushing	$ 1.00

Add $ 1.75 for postage & handling

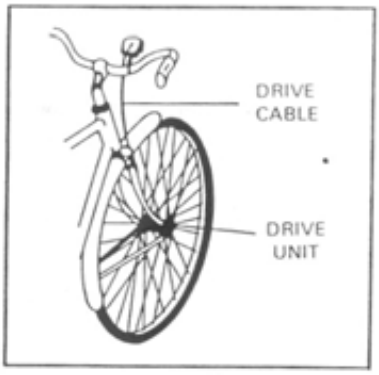
Print Name _____

Address _____

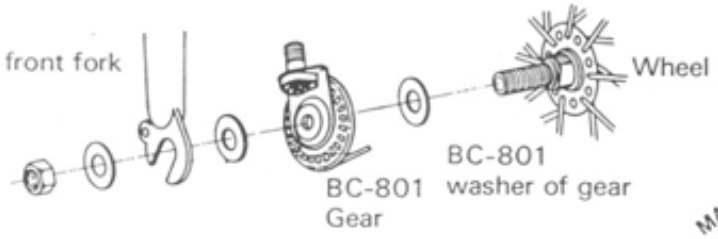


Installation

1. Mount drive wheel unit on right side of front wheel. Adjust axle bearing cones so wheel spins easily without excess play.
2. Axle bushing is to be installed if it will slide over axle, if it will not it is not needed. This bushing fits inside drive unit axle hole. Slide drive unit onto axle with drive hook towards spokes and make sure to engage in the spokes. Use spacer washers if needed to prevent hub or spokes from binding against drive unit.
3. Replace wheel in the fork. Use a washer between fork and drive unit in order to keep drive unit straight. Tighten axle nuts and align for free wheeling.
4. When bicycle is upright, drive unit must be on right side when viewed from riding position. Install speedometer head bracket to right hand side of handlebar. Attach cable to both head and drive unit.



DRIVE CABLE MUST NOT HAVE SHARP BENDS.
BE SURE FRONT WHEEL TURNS EASILY AND DRIVE UNIT IS NOT BINDING.



MADE IN TAIWAN TO THE STRICT SPECIFICATIONS OF: MIDWAY SALES, INC. COLUMBUS, OHIO

National Governing Body for Athletics in the United St

The Athletics Congress of the USA
One Hoosier Dome, Suite 140, Indianapolis, Indiana 46225 (317) 261-0500
Cable Address: ATHCONGRESS IND • Telex 27-332 • FAX (317) 261-0481

Please reply
PETER S. RIEGEL, Chair
Road Running Technical Commi
3354 Kirkham R
Columbus, OH 43
(614) 424-4009 - Of
(614) 451-5617 - Ho

August 21, 1990

Randy Swords - Midway Sales Co. - 2999 Silver Drive - Columbus, OH 43224

Dear Mr. Swords,

This will amplify our conversation of yesterday. Road running race courses are measured using a calibrated bicycle. The device used to count the revolutions of the front wheel is called a Jones counter.

The Jones Counter is simple and primitive. It consists of a Stewart-Warner drive gear which is attached to a Veeder-Root counter by means of twisted wires. The gear drive is bolted to the front axle of the bicycle, and the counter records 20 counts each time the wheel makes one revolution. The enclosed material describes the history and construction of the Jones counter.

Jones counters are presently sold by the New York Road Runners Club. When Stewart-Warner discontinued making their mechanical speedometer, they sold the remaining drive gears to NYRRC. The tooling no longer exists to make the drive gears, and supplies are getting low enough so that I am starting to worry. We need an alternate source.

I recently purchased a Bikeway speedometer, because I noticed the drive unit was almost identical to the Stewart-Warner. How much would it cost to purchase these drive units in quantity?

Alternatively, would your supplier be interested in manufacturing the entire unit, complete with counter? Expected sales volume is presently in the 500 to 700 units per year. This is low, but may be large enough to justify a production run. If the price is right, we could be prepared to buy in quantity. Alternatively, you might wish to market them yourselves.

There are no patent problems. The unit has been in the public domain for 20 years and was never patented.

The specification for the counter is simple. It must mount to the bike wheel, and count to approximately 20 to 25 each time the wheel rotates once. It should be reasonably rugged and long-lasting.

Please send pricing information for:

1) Drive units supplied in quantities of 500, 1000, 2000, 5000 units and,
2) Complete counter assemblies supplied in the same quantities.

If you have any questions, please call.

Sincerely, Pete Riegel

COMPARISON OF CALIBRATION VARIATION

Multiple measurers have met on several occasions to measure together. Thirteen measurers did it for the 1984 Olympic Marathon measurement, done in Los Angeles in 1983. IAAF had a seminar with eight in 1989, at Crystal Palace, near London. A TAC/IAAF seminar in Columbus had fourteen. Here is how they calibrated:

1983 OLYMPIC RIDE	1979 CRYSTAL PALACE	1990 COLUMBUS
13 Measurers	8 Measurers	14 Measurers
1 Calibration	2 Calibrations	2 Calibrations
1000 meters	275 meters	300 meters

DIFF	NO	PCT	DIFF	NO	PCT	DIFF	NO	PCT
0 - 1	7	17.9	0 - 1	13	27.1	0 - 1	24	28.6
1 - 2	7	17.9	1 - 2	32	66.7	1 - 2	39	46.4
2 - 3	13	33.3	2 - 3	3	6.3	2 - 3	17	20.2
3 - 4	3	7.7	3 - 4	0	0.0	3 - 4	3	3.6
4 - 5	7	17.9	4 - 5	0	0.0	4 - 5	1	1.2
5 - 6	0	0.0	5 - 6	0	0.0	5 - 6	0	0.0
6 - 7	2	5.1	6 - 7	0	0.0	6 - 7	0	0.0
7 - 8	0	0.0	7 - 8	0	0.0	7 - 8	0	0.0
NON-ZERO RIDES	39			48			84	
ZERO RIDES	13			16			28	
TOTAL RIDES	52			64			112	
AVERAGE DIFF	2.01 (counts per ride)			0.69			0.88	

In Los Angeles, 8 baselines were used. The measurers did 4 rides on the first, 1 each on the 6 calibration courses enroute, and 2 rides on the last. Data on the first calibration is the only one used here, since standard 4-ride variation is what's of interest.

A measurer gets four calibration values on his four rides. The lowest of these I call the "zero" calibration. It is the standard. It is usual that the other three rides will be somewhat above the zero ride. Therefore, in a set of four rides there will be 3 "non-zero" rides. Only the non-zero rides are summarized above.

"DIFF" is the difference of each of the 3 non-zero rides from the zero value. For example, if rides of 9277, 9276, 9276 and 9279 are made, the zero value is 9276, and the DIFFs are 1, 0, and 3. A consistent rider will have low DIFFs, while a wobbly rider will have high ones.

DIFF is affected by the length of the calibration course, since it's to be expected that longer calibration courses will produce greater differences in calibration counts. Local conditions also will affect DIFF. For example, if there is a headwind one way and a tailwind the other, the rider may get 9277, 9281, 9277, 9281. There are differences, but the measurer didn't do it. Similarly, a non-level calibration course will produce differences beyond the control of the measurer. That's why we ride both ways.

Another factor affecting variation is the method used by the measurer. Some measurers begin at a certain count, and then lock their wheel at intermediate stops, obtaining a series of five numbers. Others prefer to start each ride with an even value on the Jones counter. It makes a difference. For example, consider two perfect calibrators who never deviate, and their true count on a

300 m calibration course is 2781.2 counts. Since we cannot read the counter accurately between counts, it is common to use ".5" when the counter reads between digits, and not to attempt to interpolate with greater precision. The effect is thus:

The one who locks the wheel will get:

Actual Count	Measurer Writes	Observed Difference
00000	00000	
2781.2	2781	2781
5562.4	5562.5	2781.5
8343.6	8343.5	2781
11124.8	11125	2781.5
Average for 300 m:		2781.25
Counts per kilometer:		9270.83

The one who starts fresh each time will get:

Start Count	Finish Count	Measurer Writes	Observed Difference
00000	02781.2	02781	2781
03000	05781.2	05781	2781
06000	08781.2	08781	2781
09000	11781.2	11781	2781
			2781
			9270.00

The choice of calibration method in this example makes a difference of about 1 meter in 10 kilometers. This is small, and probably not worth worrying about. But it is one more thing we should be aware of when we think about accuracy.

I'm not sure what methods the measurers in these examples used. In any case, these are the numbers. They suggest to me that we may have improved since the Olympic ride. The Crystal Palace group showed more consistency than the Columbus group, although both groups showed average variation of less than one count per ride.