Handicapping 101

What Every Club Sailor Should Know in 101 Slides

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Modern Handicapping

Based on Absolute Units rather than a Standard Boat

- modern measurement rules are based on predicted boat speed across a wide range of wind speeds and many points of sail.
  - the handicapping authority uses a velocity prediction programme (a vpp).
- performance rules are based on relative performance data.
  - yet we can still infer absolute performance in the main.
  - and they are more readily understood in terms of absolute performance.
- we apply handicaps to boats based on a prediction of their relative performance.
  - it is trivial to deduce relative performance from absolute performance.

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Old-Fashioned Measurement Rules

- old measurement rules were based on empirical formulas.
- many inputs might have been included in these empirical formulas but there is no comparison to a modern vpp.
- old-style empirical formulas are type-forming.
  - they are no longer used in handicap racing.
  - only a shadow of these formulas exist today in development classes.
- the empirical formula would yield a rated length.
  - from this rated length another empirical formula would yield a time-on-distance (here) or a time-on-time (elsewhere) handicap.
    - and this handicap was always relative to a standard boat

Old-Fashioned Performance Rules

- performance rules directly issue a handicap.
  - the handicap is time-on-distance (here) or time-on-time (here & elsewhere).
  - the handicap is always relative to a standard boat.
- older performance rules may be still relevant today.
  - they have an extensive collection of performance data.
- handicapping authorities don't collect performance data for a single boat.
- the handicapping authority can make predictions for of a boat:
  - which already belongs to a class association;
  - which conforms to a manufacturer's standard;
  - which differs from an already handicapped boat in certain predictable ways.

Modern Handicapping with Multi-Factor Handicaps

- multi-factor or vpp-based handicaps can be specialized to the course configuration and the conditions on the day:
  - offshore, around-the-buoys or windward/leeward;
    - or % beating : % reaching : % running;
  - with or against the current;
  - using predicted wind speeds, or...
- multi-factor handicaps may adapt to wind strength automatically based on elapsed times.

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Modern Handicapping with Single-Factor Handicaps

- in club racing we use single-factor handicaps that limit the precision of our predictions.
- single-factor handicaps aggregate performance data.
  - courses need to conform to the % beating : % reaching : % running as specified by the rule or results will be skewed.
  - currents can severely distort the handicapping.
  - on a particular day wind speeds can be strongly predictive of results.
- single-factor handicaps cannot adapt to wind strength at all;
  at best handicapping will average out over a series of races.
  - a poorly localized handicap may not even average out over a series of races.

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The Rule Book's Corrected Time

Although the Rule Book Itself Doesn't Actually Define Corrected Time (cf. RRS A3 and A7)

- the rule book requires us to rank finishers by corrected time.
- corrected time is defined in terms of a "scratch" type of boat.
  - the scratch boat is representative of the fleet.
  - the choice of scratch boat doesn't actually alter how boats place.
- corrected time is also a prediction.
  - it is a prediction of how a boat, given its elapsed time, would finish were it of the scratch type.
  - provides a pretense of one-design racing of scratch type boats.

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Caveats with regard to Corrected Time

The Scratch Boat *need not be* Representative of the Fleet!

- the PHRF zero-rated boat was originally chosen to be the fastest possible boat so all PHRF handicaps would be positive.
- calculating PHRF time-on-distance corrected times with the zero-rated boat as scratch leads to an extremely simple formula.
    - this is the how PHRF was conceived.
    - for most club boats elapsed times and corrected times are very dissimilar.
    - comparing such corrected times between divisions is easy but largely pointless.

Caveats with regard to Corrected Time

The Choice of Scratch Boat *may alter* How Boats Place

- but only if a rounding rule is specified by the class rules.
  - a rounding rule, whatever the scratch boat, can never flip how boats place.
  - without rounding, ties on corrected time are uncommon.
    - untied boats without rounding can become tied with rounding.
    - whether boats round to a tie depends on the choice of scratch boat.
- rounding is a hangover from the days when corrected times were calculated by hand; rounding is old-fashioned.
  - a strict ordering with rounding implies the same strict ordering without.
  - rounding complicates the reckoning of time allowances by competitors on the water.

Some Common Corrected Time Formulas

PHRF e.g. $\check{t} = t - h \times d$

- time-on-distance
- handicap h is in units of seconds per mile from about 0 to 250.

IRC e.g. $\check{t} = t \times b$

- time-on-time
- handicap b is a unitless multiplier near 1.000.

- these formulas do not reflect best practices.
  - the choice of scratch boat is baked into the handicap.
  - the handicap has no obvious physical interpretation.

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Time-on-Distance

- corrected time is explicitly dependent on course length.
  - an incorrect course length will invalidate the results.
    - shortened courses must be accounted for.
- corrected time is calculated with respect to elapsed time so is dependent on start times.
  - however an incorrect start time will not invalidate the results.
  - reformulating corrected time in terms of time-of-day rather than elapsed time is easy.

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Time-on-Time

- corrected time is independent of course length.
- an incorrect start time will invalidate results.
  - elapsed times must be taken from a boat's starting signal or its calculated corrected time is meaningless.
    - different divisions will have different start times.
    - postponements, general recalls or other occurrences can delay start times.
    - time elapsed from the first warning signal is only meaningful if the starting signal is recorded on the same clock as finish times — elapsed time will be the difference of the two — time-of-day works just as well for this purpose.
  - it is impossible to reformulate corrected time in terms of time-of-day.

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Time-on-Distance and Time-on-Time

- time-on-distance and time-on-time are the only sensible alternatives for single-factor handicapping.
- either implicitly models how the relative performance between any two boats should vary as the wind varies.
  - A single-factor handicap lacks the information needed to specify how a particular boat actually responds to changes in the wind.
- time-on-time is generally more predictive than time-on-distance.

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Multi-Factor Specialized to Single-Factor Handicaps

- depending on the wind, many multi-factor handicaps specialize down to a single-factor time-on-distance or time-on-time handicap before racing.
- once specialized to a wind range there is little difference in predicted performance between time-on-distance and time-on-time handicapping unless the wind dramatically departs from the expected wind.

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Time-on-Time-and-Distance and Performance Curves

- time-on-time-and-distance generalizes both time-on-distance and time-on-time.
  - it uses two factors while racing.
    - and it is still amenable to mental arithmetic on the water.
- a performance curve generalizes even more.
  - six factors is the most common parametrization.
    - it is not suitable for mental arithmetic.
    - it requires preprinted time allowance tables or on-board computerization.
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Excursus on Pace versus Speed

- course-average pace p is elapsed time t divided by course length d.
- pace in general is the time in seconds needed to cover one mile.
  - pace takes units of seconds per mile.
- speed is how many miles covered in 3600 seconds.
  - speed takes units of miles per hour (knots).
- pace and speed are reciprocal to each other.
  - multiplying the pace by the corresponding speed yields unity,
    - where unity is 3600 seconds per hour.
- pace and speed are different representations of the same physical quantity.

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Single-Factor Corrected Time|Pace Formulas in General

Time-on-Distance with Handicaps Denoted h or c

$$\check{\check{t}} = t + [{}^{\bigstar}h - h] \times d \qquad \check{\check{t}} = t + [c - {}^{\bigstar}c] \times d$$

Time-on-Time with Positive Handicaps Denoted k or b

$$\check{\check{t}} = t \times [{}^{\bigstar}k \div k] \qquad \check{\check{t}} = t \times [b \div {}^{\bigstar}b]$$

- the h and k handicaps increase as boats get slower.
- the b and c handicaps increase as boats get faster.

if we divide both sides of our equations by course length...

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...having dividing both sides of our equations by course length...

Single-Factor Corrected Time|Pace Formulas in General

Time-on-Distance with Handicaps Denoted h or c

$$\check{\check{p}} = (p - h) + {}^{\star}h \qquad \check{\check{p}} = (p + c) - {}^{\star}c$$

Time-on-Time with Positive Handicaps Denoted k or b

$$\check{\check{p}} = (p \div k) \times {}^{\star}k \qquad \check{\check{p}} = (p \times b) \div {}^{\star}b$$

- the h and k handicaps increase as boats get slower.
- the b and c handicaps increase as boats get faster.

...and having expressed them in a canonical form

Comparison on Corrected Time via Canonical Pace Formulas

Via Formula $\check{\check{p}} = (p - h) + {}^{\star}h$

$$\check{\check{t}}^{A} \lessgtr \check{\check{t}}^{B}$$
$$\check{\check{p}}^{A} \lessgtr \check{\check{p}}^{B}$$
$$(p^{A} - h^{A}) + {}^{\star}h \lessgtr (p^{B} - h^{B}) + {}^{\star}h$$
$$p^{A} - h^{A} \lessgtr p^{B} - h^{B}$$

Via Formula $\check{\check{p}} = (p \div k) \times {}^{\star}k$

$$\check{\check{t}}^{A} \lessgtr \check{\check{t}}^{B}$$
$$\check{\check{p}}^{A} \lessgtr \check{\check{p}}^{B}$$
$$(p^{A} \div k^{A}) \times {}^{\star}k \lessgtr (p^{B} \div k^{B}) \times {}^{\star}k$$
$$p^{A} \div k^{A} \lessgtr p^{B} \div k^{B}$$

- comparison on corrected pace is the same as comparison on corrected time,
- and independent of the scratch handicap.

Single-Factor Corrected Pace Without Loss of Generality

Time-on-Distance

$$\check{\check{p}} \quad = (p - h) + {}^{\star}h \quad = (p + c) - {}^{\star}c$$

Time-on-Time

$$\check{\check{p}} \quad = (p \div k) \times {}^{\star}k \quad = (p \times b) \div {}^{\star}b$$

- the forms in c and b are redundant.
  - the corresponding h and c add to zero.
  - the corresponding k and b multiply to one.

Single-Factor Corrected Pace Without Loss of Generality

Time-on-Distance

$$\check{\check{p}} = (p - h) + {}^{\star}h$$

Time-on-Time

$$\check{\check{p}} = (p \div k) \times {}^{\star}k$$

- can rewrite the remaining forms in h and k to reveal even more redundancy.
  - algebraically manipulate the right-hand side of these equations.
  - to reveal an arbitrary choice of handicapping *gauge*.

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$$\check{\check{p}} = (p - h) + {}^{\star}h = p - [h - {}^{\star}h]$$

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Time-on-Time

$$\check{\check{p}} = (p \div k) \times {}^{\bigstar}k = p \div [(k \div {}^{\star}k) \div ({}^{\bigstar}k \div {}^{\star}k)]$$

- by *telescoping* the differences/ratios of handicaps.
  - e.g. handicaps relative to a standard boat with ${}^{\star}h$ or ${}^{\star}k$ in this gauge.
  - shifted $h \to h_{\star}$ or scaled $k \to k_{\star}$ are transformed but equivalent handicaps.

Single-Factor Corrected Pace Without Loss of Generality

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$$\check{\check{p}} = (p - h) + {}^{\bigstar}h = p - [h_\star - {}^{\bigstar}h_\star]$$

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Too Many Handicaps

Too Much Generality?

- there are too many ways to express the same handicapping relationship.
- there are different handicaps for time-on-distance and time-on-time.

One Preferred Handicap — the General Purpose Handicap...

- is a single factor in units of pace for either time-on-distance or time-on-time;
- has an actual physical interpretation as aggregated average pace...
  - as an absolute measure of performance rather than relative to another boat,
  - and has an equivalent aggregated average speed in knots.

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Applying a General Purpose Handicap

Time-on-Distance with a General Purpose Handicap g

$$\check{\check{p}} = (p - g) + {}^{\star}g \qquad \check{\check{t}} = t + [{}^{\star}g - g] \times d$$

Time-on-Time with the Same General Purpose Handicap

$$\check{\check{p}} = (p \div g) \times {}^{\star}g \qquad \check{\check{t}} = t \times [{}^{\star}g \div g]$$

- the general purpose handicap g supplants the h and k in the formulas.
- it works for any time-on-distance or time-on-time handicapping.
- it gives context to handicaps which are otherwise opaque.

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  - but precomputing the bracketed term obscures that context.
    - PHRF and IRC handicaps can be considered such a precomputed expression.
    - determining the GPH for a single boat recovers the GPH for all boats.

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    - determining the GPH for a single boat recovers the GPH for all boats.

A PHRF Handicap for Time-on-Time

- a PHRF rating h is the difference in GPH from that of the zero-rated boat:
  - $h = g - {}^{\text{zero-rated}}g$.
- to recover the GPH for time-on-time handicapping:
  - ${}^{\text{zero-rated}}g$ is about $600\,\mathrm{s/mi} \pm 100\,\mathrm{s/mi}$ depending on local conditions,
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  - $\Delta g = \Delta h$.
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  sensibly its value for ${}^{\text{zero-rated}}g$;

  misguidedly a transformation $h \to b$ hiding ${}^{\text{zero-rated}}g$ in the formula.

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A Transformation $h \to b$ Hiding ${}^{\text{zero-rated}}g$ in the Formula

For Lake St. Clair

${}^{\text{standard}}g$ and ${}^{\text{zero-rated}}g$ are fixed parameters
${}^{\text{our}}h$ is our PHRF rating
${}^{\text{our}}g$ is the corresponding GPH
${}^{\text{our}}b$ is the corresponding *time correction factor*

$$ {}^{\text{our}}b = \frac{\overbrace{650\ \mathrm{s/mi}}^{{}^{\text{standard}}g}}{\underbrace{\underbrace{557\ \mathrm{s/mi}}_{{}^{\text{zero-rated}}g} + {}^{\text{our}}h}_{{}^{\text{our}}g}} $$

- boats aren't as fast on average as the low ${}^{\text{zero-rated}}g$ would suggest.
  - for our purposes, this inconsistency is irrelevant.
  - we must accept the handicapping as is.

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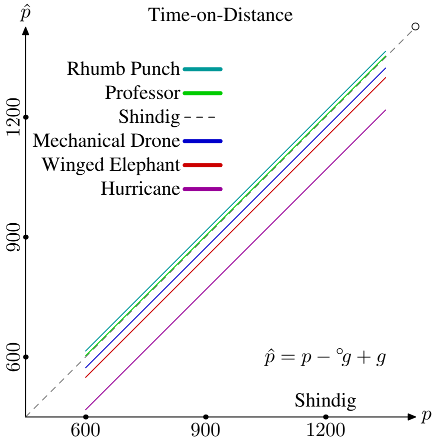
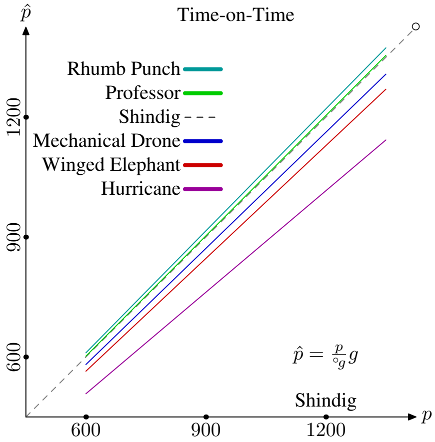
General Purpose Handicaps for Sample Boats

Boat	g	Δg	Make
Hurricane	729(12:09)	−132(2:12)	Melges 24
Winged Elephant	810(13:30)	−51	Wavelength 24
Mechanical Drone	834(13:54)	−27	C&C 30
Shindig	861(14:21)	∘	Viking 28
the Professor	864(14:24)	+3	J 22
Rhumb Punch	876(14:36)	+15	Mirage 33

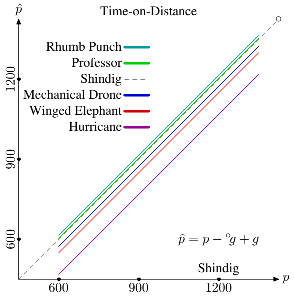
these handicaps are rounded to the closest multiple of $3\,{}^{\mathrm{s}}\!/_{\mathrm{mi}}$.

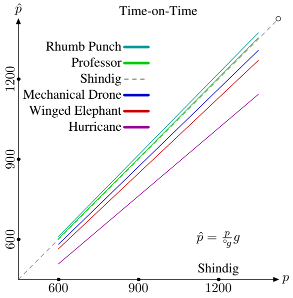
Graphing Time-on-Distance side-by-side with Time-on-Time

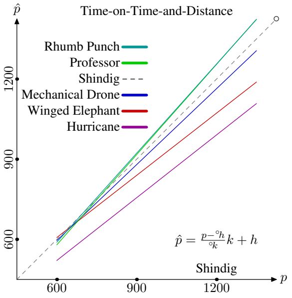




An Excursus on Graphing Time-on-Time-and-Distance







Response to the wind strength:

- for single-factor handicaps is embedded in the model;
- for time-on-time-and-distance is contained in the handicap.

Time and Pace Allowances

Defined from Our Perspective

From Our Perspective for a Given Competitor

- a time allowance Δt is the time ahead or behind us the competitor must finish in order to tie with us after handicapping is applied.
- a pace allowance Δp is a difference in pace necessary for a tie.
- multiplication by course length connects:
  - our pace p to our elapsed time t;
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Time-on-Distance

- pace allowance for a competitor Δp is Δg
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- we can turn a pace allowance into a time allowance by dropping per-mile from all the units in the proportionality,
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Our Boat *Shindig* with Handicap $g = 861\,{}^{\mathrm{s}}/_{\mathrm{mi}}$...

In General

- we have $g = 861\,{}^{\mathrm{s}}/_{\mathrm{mi}} = {}^{14\,\mathrm{min}\,21\,\mathrm{s}}/_{\mathrm{mi}}$.
- on average we should take:
  - $861\,\mathrm{s} = 14\,\mathrm{min}\,21\,\mathrm{s}$ to complete a mile of the course;
  - $287\,\mathrm{s} = \ \ 4\,\mathrm{min}\,47\,\mathrm{s}$ to complete a third of a mile;

For a $4{}^{1}/_{3}$ mi Long Course

- we add the expected elapsed time over 4 mi to that over ${}^{1}/_{3}$ mi...

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Our Boat *Shindig* on a 4¹⁄3 mi Course...

$$\begin{array}{rrr} & 57\,\text{min}\,24\,\text{s} \propto & 4\,\text{mi} \\ + & 4\,\text{min}\,47\,\text{s} \propto & 1/3\,\text{mi} \\ \hline & 62\,\text{min}\,11\,\text{s} \propto & 4\tfrac{1}{3}\,\text{mi} \end{array}
\left\{ \begin{array}{rrl} t \propto & d & \text{(on average)} \\ 14\,\text{min}\,21\,\text{s} \propto & 1\,\text{mi} & \\ \hline 28\,\text{min}\,42\,\text{s} \propto & 2\,\text{mi} & (2\times) \\ 43\,\text{min}\;\;3\,\text{s} \propto & 3\,\text{mi} & (3\times) \\ 57\,\text{min}\,24\,\text{s} \propto & 4\,\text{mi} & (4\times) \\ 1\,\text{h}\,11\,\text{min}\,45\,\text{s} \propto & 5\,\text{mi} & (5\times) \\ \vdots & & \\ \hline 4\,\text{min}\,47\,\text{s} \propto & 1/3\,\text{mi} & (1/3\times) \\ 9\,\text{min}\,34\,\text{s} \propto & 2/3\,\text{mi} & (2/3\times)\ldots \end{array} \right.$$

Our Boat *Shindig* on a $4^1/_3$ mi Course

And an Elapsed Time of 1 h 2 min 11 s

On Average

- the expected elapsed time for $4^1/_3$ mi is 1 h 2 min 11 s.

At an Elapsed Time of 1 h 2 min 11 s

- a time allowance for time-on-time will be the same as for time-on-distance.

Our Boat *Shindig* on a 4 1/3 mi Course

And an Elapsed Time of 1 h 2 min 11 s

On Average

- the expected elapsed time for 4 1/3 mi is 1 h 2 min 11 s.

At an Elapsed Time of 1 h 2 min 11 s

- a time allowance for time-on-time will be the same as for time-on-distance.

For Our Competitor *Rhumb Punch* where $\Delta g = 15\,\mathrm{s}/\mathrm{mi}$

For Time-on-Distance

- for each mile of course the time allowance Δt increases by $15\,\mathrm{s}$;
- for each additional $1/3\,\mathrm{mi}$ the time allowance Δt increases by $5\,\mathrm{s}$.

For Time-on-Time

- the ratio of Δt to $15\,\mathrm{s}$ is equal in proportion to the ratio t to $14\,\mathrm{min}\,21\,\mathrm{s}$.
- for each:
  - $14\,\mathrm{min}\,21\,\mathrm{s}$ of elapsed time t the time allowance Δt increases by $15\,\mathrm{s}$;
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For Time-on-Time

- the ratio of Δt to 15 s is equal in proportion to the ratio t to $14\ \mathrm{min}\ 21\ \mathrm{s}$.
- for each:
  - $14\ \mathrm{min}\ 21\ \mathrm{s}$ of elapsed time t the time allowance Δt increases by $15\ \mathrm{s}$;
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For Our Competitor *Rhumb Punch* where $\Delta g = 15\ \mathrm{s/mi}$

For Time-on-Distance

- for each mile of course the time allowance Δt increases by 15 s;
- for each additional $1/3$ mi the time allowance Δt increases by 5 s.

For Time-on-Time

- the ratio of Δt to 15 s is equal in proportion to the ratio t to 14 min 21 s.
- for each:
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For Our Competitor *Rhumb Punch* using Time-on-Distance

A $4^1/_3$ mi course yields a time allowance of 65 s.

$$\begin{array}{rrcl} & 60\,\mathrm{s} & \propto & 4\,\mathrm{mi} \\ + & 5\,\mathrm{s} & \propto & {}^1/_3\,\mathrm{mi} \\ \hline & 65\,\mathrm{s} & \propto & 4^1/_3\,\mathrm{mi} \end{array} \left\{ \begin{array}{rcll} \Delta t & \propto & d & \text{(time-on-distance)} \\ 15\,\mathrm{s} & \propto & 1\,\mathrm{mi} & \\ \hline 30\,\mathrm{s} & \propto & 2\,\mathrm{mi} & (2\times) \\ 45\,\mathrm{s} & \propto & 3\,\mathrm{mi} & (3\times) \\ 60\,\mathrm{s} & \propto & 4\,\mathrm{mi} & (4\times) \\ \hline 5\,\mathrm{s} & \propto & {}^1/_3\,\mathrm{mi} & ({}^1/_3\times) \end{array} \right.$$

For Our Competitor *Rhumb Punch* using Time-on-Time

An elapsed time of $1\,\mathrm{h}\,2\,\mathrm{min}\,11\,\mathrm{s}$ yields a time allowance of $65\,\mathrm{s}$.

$$\begin{array}{rrcr} & 60\,\mathrm{s} & \propto & 57\,\mathrm{min}\,24\,\mathrm{s} \\ + & 5\,\mathrm{s} & \propto & 4\,\mathrm{min}\,47\,\mathrm{s} \\ \hline & 65\,\mathrm{s} & \propto & 62\,\mathrm{min}\,11\,\mathrm{s} \end{array}
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For Our Competitor *Rhumb Punch*

On average Δt, t and d vary in lockstep.

$$
\begin{array}{rrcrcr}
 & 60\,\mathrm{s} & \propto & 57\,\mathrm{min}\,24\,\mathrm{s} & \propto & 4\,\mathrm{mi} \\
+ & 5\,\mathrm{s} & \propto & 4\,\mathrm{min}\,47\,\mathrm{s} & \propto & {}^1\!/_3\,\mathrm{mi} \\
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\end{array}
\quad
\left\{
\begin{array}{rcrcrl}
\Delta t & \propto & t & \propto & d & \\
15\,\mathrm{s} & \propto & 14\,\mathrm{min}\,21\,\mathrm{s} & \propto & 1\,\mathrm{mi} & \\
\hline
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\end{array}
\right.
$$

For an actual race which departs from the average, time allowances are dependent on either time or distance depending on the style of handicapping...

For Our Competitor *Rhumb Punch* using Time-on-Time

Were we to take exactly one hour to finish a race:

- the time allowance of 60 s for 57 min 24 s would fall short;
- the time allowance of 65 s for 62 min 11 s would overshoot;
- we need about two and half minutes worth of additional time allowance to round out the 57 min 24 s worth.
  - every minute of elapsed time increases the time allowance by about 1 s.
  - 2.5 s $\propto$ 2.5 min, approximately.
  - this would give a total time allowance of about 62.5 s.
- to be certain of the win, we must beat Rhumb Punch by 1 min 3 s.

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A Time Allowance Table

Shindig	14:21
the Professor	+3
Rhumb Punch	+15
Mechanical Drone	−27
Winged Elephant	−51
Hurricane	−2:12

	Shindig	Pr +	RP +	MD −	WE −	Hu −
1/3	4:47	1	5	9	17	44
2/3	9:34	2	10	18	34	1:28
1	14:21	3	15	27	51	2:12
2	28:42	6	30	54	1:42	4:24
3	43:03	9	45	1:21	2:33	6:36
4	57:24	12	1:00	1:48	3:24	8:48
5	1:11:45	15	1:15	2:15	4:15	11:00
6	1:26:06	18	1:30	2:42	5:06	13:12
7	1:40:27	21	1:45	3:09	5:57	15:24
8	1:54:48	24	2:00	3:36	6:48	17:36
9	2:09:09	27	2:15	4:03	7:39	19:48

An Expanded Time Allowance Table

Shindig		Pr +	RP +	MD −	WE −	Hu −
1/3	4:47	1	5	9	17	44
2/3	9:34	2	10	18	34	1:28
1	14:21	3	15	27	51	2:12
1 1/3	19:08	4	20	36	1:08	2:56
1 2/3	23:55	5	25	45	1:25	3:40
2	28:42	6	30	54	1:42	4:24
2 1/3	33:29	7	35	1:03	1:59	5:08
2 2/3	38:16	8	40	1:12	2:16	5:52
3	43:03	9	45	1:21	2:33	6:36
3 1/3	47:50	10	50	1:30	2:50	7:20
3 2/3	52:37	11	55	1:39	3:07	8:04
4	57:24	12	1:00	1:48	3:24	8:48
4 1/3	1:02:11	13	1:05	1:57	3:41	9:32
4 2/3	1:06:58	14	1:10	2:06	3:58	10:16

⋮

5	1:11:45	15	1:15	2:15	4:15	11:00
5 1/3	1:16:32	16	1:20	2:24	4:32	11:44
5 2/3	1:21:19	17	1:25	2:33	4:49	12:28
6	1:26:06	18	1:30	2:42	5:06	13:12
6 1/3	1:30:53	19	1:35	2:51	5:23	13:56
6 2/3	1:35:40	20	1:40	3:00	5:40	14:40
7	1:40:27	21	1:45	3:09	5:57	15:24
7 1/3	1:45:14	22	1:50	3:18	6:14	16:08
7 2/3	1:50:01	23	1:55	3:27	6:31	16:52
8	1:54:48	24	2:00	3:36	6:48	17:36
8 1/3	1:59:35	25	2:05	3:45	7:05	18:20
8 2/3	2:04:22	26	2:10	3:54	7:22	19:04
9	2:09:09	27	2:15	4:03	7:39	19:48
9 1/3	2:13:56	28	2:20	4:12	7:56	20:32
9 2/3	2:18:43	29	2:25	4:21	8:13	21:16

Refining Approximations for Time Allowances

Shindig	$\Delta t \propto t$ Approximations			
the Professor	$1\,\mathrm{s} \propto 4\,\mathrm{min}\,47\,\mathrm{s}$	$1\,\mathrm{s} \propto 5\,\mathrm{min}$		
Rhumb Punch	$5\,\mathrm{s} \propto 4\,\mathrm{min}\,47\,\mathrm{s}$	$1\,\mathrm{s} \propto 1\,\mathrm{min}$ (via $5\,\mathrm{s} \propto 5\,\mathrm{min}$)		
Mechanical Drone	$9\,\mathrm{s} \propto 4\,\mathrm{min}\,47\,\mathrm{s}$	$1\,\mathrm{s} \propto 32\,\mathrm{s}$ (via $3\,\mathrm{s} \propto 1\,\mathrm{min}\,36\,\mathrm{s}$)		
Winged Elephant	$17\,\mathrm{s} \propto 4\,\mathrm{min}\,47\,\mathrm{s}$	$4\,\mathrm{s} \propto 1\,\mathrm{min}\,7\,\mathrm{s}$	$2\,\mathrm{s} \propto 33.5\,\mathrm{s}$	$1\,\mathrm{s} \propto 17\,\mathrm{s}$
Hurricane	$44\,\mathrm{s} \propto 4\,\mathrm{min}\,47\,\mathrm{s}$	$11\,\mathrm{s} \propto 1\,\mathrm{min}\,12\,\mathrm{s}$	$8\,\mathrm{s} \propto 52.5\,\mathrm{s}$	$1\,\mathrm{s} \propto 7\,\mathrm{s}$

Wrap Up

- modern handicapping can be highly predictive of performance.
    - in club racing we don't take advantage of the precision offered.
- the GPH is the one true single-factor handicap.
    - even when we don't realize we are using it.
- time allowances are easily reckoned for time-on-time.