

A Note on Progressive ECHO Handicapping

Fundamental Principles

1. **Objective** – all boats should be treated alike in accordance with a set procedure. Subjective input should not occur unless absolutely necessary and then only in defined circumstances and in accordance with clear and stated guidelines.
2. **Transparent** – the process by which handicaps are determined should be published and open to scrutiny by all. Every competitor should be able to ask for an explanation of **how any handicap was determined**.
3. **Fair** – if the above two principles are followed then handicaps will be demonstrably fair to all competitors.

ECHO – A Speed Index

Because cruisers are not one-design¹ a system of adjusting the elapsed time [ET] each boat takes to finish a course is necessary to account for the basic speed difference between boats. The two systems² used in Ireland, ECHO and IRC, are described as time on time³ [TOT] adjustment or correction systems where the elapsed time [ET] is multiplied by a time correction factor [TCF⁴] to give 'corrected' time $ET \times TCF = CT$.

In ECHO, after each race **the speed of each boat⁵ relative to every other boat** is calculated by the results program⁶ and expressed as an **index** – hence speed or performance index [PI]. These indices are averaged from race to race [or after a series of races] and these averages become the new time correction factors TCFs or handicaps for the next race. This method of handicapping is generally referred to as performance based handicapping, and in this respect ECHO it is a lot like golf handicapping.

What do the PI numbers mean? The PI numbers are an exact measure of the **relative speed of the boats in the series** – fastest slowest, faster slower - can all be identified with absolute accuracy. That is what the PI is - a measure of **relative speed** but not

¹ i.e. equal or equalised in terms of basic speed potential

² **IRC** is measurement based while **ECHO** is performance based.

³ In the US and other countries a system of time allowances based on the length of the course is used. This is called time on distance [TOD] handicapping.

⁴ Unity i.e. One to 3 decimal places is used as the basis of the TCF scale. This ensures that the corrected times are recognisably similar to the original elapsed times i.e. in percentage terms the adjustments are relatively small.

⁵ With its crew i.e. the totality of the performance on the day. The time taken by every boat incorporates the whole of that boat's performance; the 5 seconds lost at the start, the gain made by picking the favoured side of the beat, the delay in getting the spinnaker up, the foul-up in taking it down, the good/bad tacks on the 2nd beat etc etc – everything is included in the elapsed time.

⁶ <http://www.sail100.org/saild.htm>

actual speed i.e. in terms of miles or kts per hour - because we do not know the distances sailed so we cannot say whether a boat was doing 5 or 6 or whatever kts per hour on average⁷. What we do have are common distances - the course to be sailed - and the time taken by each boat to sail that course. From that it is a simple matter to calculate the PI which **exactly expresses the relative time taken by each boat to sail that common distance i.e. a relative speed index.**

The core calculation in ECHO is a simple arithmetic operation with **no evaluative element whatsoever** i.e. $8/4=2 \times 4=8$ is the basic maths methodology⁸. The calculation makes no judgment - there is no subjective element; it is totally mathematically objective; it does not even know who wins or loses!⁹ It is a mathematical given of this operation that when the elapsed times of the boats are adjusted back by this index the result will be a common adjusted time for all boats, alternatively, these are the handicaps that the boats should have had for the result to have been a dead heat of all boats – see Table A below.

The nature of this calculation is that the faster boat in any race will ALWAYS have a higher index value than the slower boat.¹⁰ Therefore in any set of performance handicaps a boat with a higher average speed should always have a higher handicap than a boat with a lower average speed.

Table A

	Elapsed Time	ECHO Index	Fastest	Common
			Slowest	Time
				01:33:39
Boat	ET	1.020		ET X Index
Bon Exemple	01:17:52	1.203	Fastest	01:33:39
Fools Gold	01:18:38	1.191	slower	01:33:39
Rockabill V	01:19:18	1.181		01:33:39
Joker II	01:21:01	1.156		01:33:39

⁷ With current logging technology it should be possible to have an accurate common distance for any course. It would then be a simple matter to show the average real speed of each boat on that course.

⁸ 'A function and its inverse function can be described as the "DO" and the "UNDO" functions. A function takes a starting value, performs some operation on this value, and creates an output answer. The inverse function takes the output answer, performs some operation on it, and arrives back at the original function's starting value.'

⁹ It does make a form of evaluative 'judgment' in the corrected times in that the winner will receive the greatest positive adjustment to its TCF – this is by comparing the race handicap with the race performance index – see table B. But in the calculation of the index in the first instance there is no evaluation or no indication of who has won.

¹⁰ An index is a more abstract way of measuring and expressing data which allows for easier and more effective comparison than using the unabstracted original data. An index expresses one dimension of a data set. To create an index the data value should be measured against [divided into (or by)] a constant or benchmark number.

Jelly Baby	01:26:12	1.086		01:33:39
Raptor	01:26:42	1.080		01:33:39
Storm	01:29:43	1.044		01:33:39
Boomerang	01:29:53	1.0419		01:33:39
Ruth	01:29:55	1.0415		01:33:39
Dear Prudence	01:34:05	0.995		01:33:39
Jedi	01:34:23	0.992		01:33:39
Jetstream	01:35:12	0.984		01:33:39
Axiom	01:35:24	0.982		01:33:39
Gringo	01:36:18	0.9725		01:33:39
Mojito	01:36:21	0.9720		01:33:39
Fox in Sox	01:36:22	0.9718		01:33:39
Black Velvet	01:36:50	0.967		01:33:39
Zuri	01:38:18	0.953		01:33:39
Flashback	01:39:49	0.938		01:33:39
Indecision	01:40:06	0.936		01:33:39
Something Else	01:40:44	0.930		01:33:39
Powder Monkey	01:41:04	0.927	faster	01:33:39
Jump The Gun	01:43:00	0.909	Slowest	01:33:39

The **performance index effectively ranks the group of boats - from fastest to slowest or slowest to fastest**. The Table clearly shows that **Bon Exemple** had the fastest time and the highest index number and **Jump the Gun** had the slowest time and the lowest index number.

The benefit of the index method is that it is 'transportable' i.e. a series of indices can be carried forward from race to race in a meaningful way. An index is more abstract or dimensionless than elapsed time, which will be different for each boat from race to race. It is simply a way of expressing the elapsed times/relative speed in a form which allows those times/speeds to be averaged for a series of races. When the index is averaged for a series of races it provides an entirely valid basis for saying what the **average relative speed of each boat in the series was or, predicting the finishing order of the boats in the next race. It is at this point that the index becomes a set of handicaps** and when the elapsed times are then corrected by that index/TCFs the corrected results should be very close.¹¹

¹¹ In theory a dead heat.

In Progressive ECHO [P-ECHO] handicaps are **adjusted automatically** by the results program¹² after each race so that the adjusted handicap is a cumulative average of the races as they progress – hence **progressive handicapping**. There are many possible methods of calculating this average. The method now used in P-ECHO is a form of moving average where a percentage of the race handicap is added to a percentage of the race performance index¹³ to arrive at the Next Race Handicap[NRH]. The method of calculating the index is set out in the accompanying excel file 'Performance Analysis 2015' in sheet 'race 6 analysis'.

This means that as the series of races progresses the average will reflect with increasing accuracy the current relative speed performance of each boat in the fleet – it is a continuous process of fine tuning the TCF from race to race.

What is the goal of performance handicapping?

In theory, starting each race, the assumption of ECHO is that all boats have been equalised [which is accepted as not being true if you do not start from performance based numbers] by measurement of earlier performances and that those are now captured and expressed in the current TCF. Consequently, **the theoretical expectation is that the race will be a dead heat of all the competitors**, or more realistically - because all performances can never be identical from one race to the next – that **every boat in the fleet has an equal chance of winning**¹⁴ - **the winner can come from the fastest or slowest boats** - **there is no certainty about which boat might win**¹⁵ – **the best relative performance on the day wins**. This feature – that every boat has an equal chance of winning – is **a strong incentive to improve your performance in the next race**, 'if we do a little bit better we improve our chances of winning, if we improve the most we will win!'

And this is what happens in ECHO - there will usually be a different winner in each race - and the overall winner of a series may not win any race, unlike IRC where a string of bullets from the winner is not uncommon. The practical goal is to have corrected times as close as possible¹⁶ - and in practical terms that is being achieved - taking into account all the vagaries of boat types, sailing ability and weather conditions prevailing. Because of the

¹² Sail 100 < <http://www.sail100.org/>> is the only results program that calculates ECHO Performance Indices and operates Progressive ECHO correctly or at all.

¹³ To give 100%. In mathematical terms this is described as exponential smoothing - in simple moving averages all races are weighted equally, in exponential smoothing decreasing weight is assigned as the races get older. In other words, recent races are given relatively more weight in the NRH than earlier races.

¹⁴ 'The principle of the handicapping system is to create a situation where each horse **has an equal chance of winning**' <http://www.goracing.ie/HRI/Whats-On/About-Horse-Racing/Racing-Explained/8---Handicapping/>

¹⁵ Unlike IRC where the number of likely winners may be drawn from as few as 2 or 3 boats in a 15 boat class.

¹⁶ This is a key parameter in testing the correctness of the handicaps for a group of boats. A better test is a correlation test between the order of finish and the TCFs of the boats. If the handicaps are correct the first to finish will have the highest handicap and the last will have the lowest handicap etc.

spread of results/winners it is common for the final outcome of a series not be determined until the last race. Results since the introduction of P-ECHO bear this out particularly by comparison with results calculated under IRC.

Why and how are handicaps increased/decreased?

In P-ECHO, the adjustment is based on the performance in the last race. There is no necessary relationship between the increase or decrease of the current handicap after each race and a boat's standing in the overall series.¹⁷ It boils down to this question; how much did I beat my [current] handicap by? The boat that beats its current handicap by the greatest amount wins - and so on pro rata down the corrected list to the boat that finishes last. Hence the boat that finishes first will get the greatest positive adjustment and the boat that finishes last will get the greatest negative adjustment. It will always be so under the arithmetic of the system.

Wherever you are in the **overall results** - top or bottom - you can do well in an individual race, you have an equal chance. But once you win [or do well], once you appear in the top half - or the bottom half for that matter - you're handicap will be adjusted up or down and will continue to be adjusted from race to race, up or down, depending on the result of that last race.

Table B

Boat	Corrected	Race H'cap	ECHO Index	Next Race Handicap	H'cap	Highest
	Time	0.60	0.40	60%Race Handicap	Change	Lowest
				+		Adj.
		1.020	1.020	40%ECHO Index	0.000	
Fools Gold	01:22:34	1.050	1.191	1.106	0.056	Highest
Joker II	01:24:20	1.041	1.156	1.087	0.046	
Bon Exemple	01:25:58	1.104	1.203	1.144	0.040	
Rockabill V	01:27:23	1.102	1.181	1.134	0.032	
Raptor	01:28:10	1.017	1.080	1.042	0.025	
Ruth	01:30:33	1.007	1.041	1.021	0.014	
Zuri	01:32:12	0.938	0.953	0.944	0.006	
Axiom	01:32:32	0.970	0.982	0.975	0.005	
Jedi	01:32:52	0.984	0.992	0.987	0.003	
Boomerang	01:33:34	1.041	1.042	1.041	0.000	
Storm	01:34:55	1.058	1.044	1.052	-0.006	

¹⁷ This part was written to answer a question that arose in VDRL13 – ‘Why did my handicap increase when I’m in the bottom half of the fleet in the overall standings?’

Jetstream	01:34:55	0.997	0.984	0.992	-0.005	
Dear Prudence	01:35:07	1.011	0.995	1.005	-0.006	
Indecision	01:35:12	0.951	0.936	0.945	-0.006	
Flashback	01:36:13	0.964	0.938	0.954	-0.010	
Jelly Baby	01:36:43	1.122	1.086	1.108	-0.014	
Black Velvet	01:38:06	1.013	0.967	0.995	-0.018	
Fox in Sox	01:38:12	1.019	0.972	1.000	-0.019	
Mojito	01:38:17	1.020	0.972	1.001	-0.019	
Jump The Gun	01:38:28	0.956	0.909	0.937	-0.019	
Powder Monkey	01:38:38	0.976	0.927	0.956	-0.020	
Gringo	01:39:40	1.035	0.973	1.010	-0.025	
Something Else	01:48:29	1.077	0.930	1.018	-0.059	Lowest

2 Points re adjustment

1. The ECHO Index is based on the **actual time**¹⁸ taken to sail the course i.e. elapsed time – ET, not corrected time – CT. The amount of adjustment is exclusively derived from each individual boat's elapsed time/performance and exactly expresses that time taken – the more time you win/beat other boats by the higher the adjustment, the more time you are beaten by the lower the adjustment. Please look at sheet 'Race 6 analysis' in the accompanying excel file and change SOMETHING ELSE'S time, say by 10 minutes plus or minus and see the effect it has on the revised TCFs - of all the boats. Look at the overall effect in column Q as you make the change. Note that if you have an extreme win it pulls the mid-point for plus/minus adjustments up and vice versa for a very poor performance [which is why they may be excluded from the calculation sometimes] This is driven by the fact that the equation requires the total adjustments to balance – so that the revised average handicap is equal to the opening average handicap.
2. The **RATE of adjustment**¹⁹ is also a matter to be considered. In an open event with many if not all boats an unknown quantity to start - and a very limited number of races in which to make the performance factor work we used [again VDLR13] a high rate of adjustment – 60/40, 60% of the race TCF and 40% of the performance index for that last race is used to provide the NRH. This is a high rate of adjustment, and it might be preferable to use a lower rate but circumstances dictate the 60/40 approach. Again you can use sheet 'Race 6 analysis' to check the rate of adjustment by changing the 60/40

¹⁸ Because this is one of the 2 components of the speed equation; Distance over Time is equal to Speed $D/T = S$

¹⁹ How much the TCF changes from race to race.

split to say a 80/20 split and you can see a much lower rate of adjustment. If you examine the changes between boats as well you will see that whereas the first boat will get a large adjustment as against the last boat she will only get a small adjustment as against the 2nd boat. This is what you might use in a stable club situation.

General Handicapping Issues

The principal issues that a handicapper is trying to resolve in managing a set of personal performance based handicaps for a fleet include the following:

1. The **accuracy of current handicaps** which is related to the question of the frequency with which handicaps are revised – and the quality of information available.
2. The issue of **manual or subjective input** in determining handicaps,
3. Which is closely related to the problem created by boats that:
 - a) are **not racing regularly**, and/or
 - b) are **not showing their true colours** [for a variety of reasons] on the race course.

If there were no anomalous results and everybody raced all the time - to their full potential - there would be no need for any manual input and the computer could do it all – but that is not the reality of cruiser racing.

4. The **issue of stability/certainty** in handicaps – having a definite or stable rather than a moving target to aim at for competitors.
5. **Transparency** – the need to show users that **handicaps are being managed in a fair and objective manner.**

The task of the handicapper is to try and resolve these issues as fairly as possible. All of the issues are interrelated – and capable of more than one solution - depending on the regularity of racing, the number of races in the event, open or club based, the preferences of sailors and race management, the quality of handicap management etc.

Features of Progressive Handicapping

Progressive handicapping has some strong features in addressing the above issues – as well as one inevitable downside.

The major attractions are:

- **No subjective input** to individual handicaps - subject to one exception explained below.
- **Complete accuracy of the current handicaps** of boats racing. A boat's handicap, even after 2 races, will be very close to what that boat and crew are capable of sailing to – high or low, good or bad – relative to the other boats in the fleet. This is particularly the case in events with a minimum series of races – so in a club situation

with regular racing between established fleets current handicaps should be extremely accurate.

- **Transparency** is a critical issue. It is imperative for the proper management of any handicap system that its workings are transparent – if it is transparent it will be fair – because any skipper can come along at any time and ask what their handicap is and how it was arrived at? And ask the same question in relation to any boat in the fleet – and they are entitled to a full answer to those questions.

The one downside is the loss of stability – handicaps do not remain the same from race to race²⁰ – by definition you cannot have revisions after every race and stable handicaps over time – the two are mutually exclusive. But experience shows that this issue is more apparent than real in that once handicaps settle down, again after as few as two or three races, the range of change in handicaps for the majority of the boats relative to each other can be as little as a few points either way. The range of change is also very dependent on the accuracy of the opening handicaps – the more accurate the opening handicaps the less the adjustment that has to be made from race to race.

Situations requiring manual intervention:

1 – Occasional or irregular turnout

This is one major issue that cannot be addressed directly by the Sail100 results program [or any program] and that is the problem of boats that are not racing regularly – a program cannot measure what does not exist – in this case performance. So this issue remains and must be addressed by direct management input. The old principle in ECHO was that in this situation the validity and integrity of the established handicaps of regular racing boats must be protected; that principle remains valid. How to do that is the question. There are some boats that only appear on the race course for a few events a season and usually - to make matters more difficult - these are prestigious events. There is no point in throwing the book at these competitors and loading their handicap to the point where they come in last or next to last on corrected time by a substantial margin. If such boats have a known established performance relativity and there is no likelihood that the skipper has turned into Russell Coutts overnight then use that established relativity – even if it is a year since the boat last took part in a race! But if there is any genuine doubt about the old handicap then it is the duty of the handicap officer to increase it to a level which is fair to the established handicaps of the regular racing fleet. This is manual input – and there is no way it can be avoided.

²⁰ Unlike IRC which only changes infrequently – after measurement changes or from year to year as the IRC algorithm is fine tuned.

2 – Anomalous results – ‘sandbagging’?

Another problem that occurs is the issue of anomalous results for individual boats or ‘sandbagging’ as it is sometimes described. My view is that this is a very rare to exceptional occurrence – at least in the true ‘sandbagging’ sense i.e. **deliberately** having a poor result to gain a favourable handicap for future races. More commonly there may be occasions, when through no fault of the skipper, a boat comes in a position down the fleet with a corrected time that is clearly not the norm for that boat and crew. It will always be down rather than up – because no one is capable of sandbagging their way to the front of the fleet – and if they win, however they win – they should be prepared to pay the penalty in an increased handicap, as well as take the prize.

Perhaps software could be programmed to deal with this extremely poor result situation but I feel it is best dealt with by direct manual intervention in the program. In such a case there is a facility in the results program to ignore this result and let the original handicap for that race stand as the handicap for the next race i.e. no change based on the outlier race.

BASIC ASSUMPTIONS BEHIND PERFORMANCE HANDICAPPING:

The ECHO methodology depends on certain assumptions being generally true. If these assumptions are false or do not apply then the basis for the handicap system is undermined. The main assumptions include:

- That something other than rating based or scratch results is required.
- That there is some **reasonable level of consistency/predictability** in competitors performance from race to race [This requires that competitors make an honest effort to sail to the best of their ability in every race²¹]
- That performances of similar groups of boats at different locations that do not regularly sail against each other are similar/comparable
- **ECHO handicaps are essentially a prediction** based on the principle that future/the next performance will be similar to [recent] past performance

A Note on ECHO v IRC

- IRC is sometimes described as a ‘rating’ system as distinct from a ‘handicap²²’ system to express the idea that its time adjustment factor refers to the boat only. It measures the boat and sails and converts these measurements to a **time adjustment factor** [called TCC] which essentially says what the **speed of the boat is relative to other measured boats. It makes no allowance for crew skill whatsoever.** A boat’s TCC is a **prediction** of how fast a boat should be. In a sense racing under IRC is like playing scratch golf while racing under ECHO is similar to playing off handicap.

²¹ Which requires a consistent regular [pool of] crew

²² Note horse racing handicap site refers to ‘handicap ratings’ - using both words.

- ECHO measures **historic relative speed** of the boat and crew – the actual performances - and expresses that as an average time adjustment factor [TCF]. As a **measurement** of past performance this method is extremely accurate – as accurate as the timekeeping at the finish line.²³ ECHO then assumes that in the next race the boat and crew will sail close to their earlier performances i.e. it also is a **prediction** like IRC but of the boat and crew speed and not just that of the boat. As a **measurement** ECHO is extremely accurate; as a **prediction** it is subject to the standard financial adviser's disclaimer '***past performance is no guarantee of future results!***' but, well managed, it does predict the ranking/finishing order of boats much more accurately than IRC. But this is to be expected as IRC makes no allowance for crew skill.

Denis Kiely

Revised 10-05-2015

²³ Because the PI for any race is simply the actual time taken by every boat expressed in a dimensionless manner and the TCF is the average of those PIs.