

The flavour of whisky

Lagavulin, Talisker, Ardbeg—the names roll off the tongue and the liquid slides gloriously down the throat. Single malt Scotch whiskies count among the pleasures of life. But how can you classify their complex and various flavours? **David Wishart** savours a smoky, medicinal, peat-filled Islay and comes up with a scheme.

When George IV acceded to the throne in 1820, no reigning British monarch had visited Scotland for 170 years. The Scottish establishment, led by Sir Walter Scott, the father of historical fiction, resolved to change that and invited the newly crowned King George to Edinburgh. The King accepted, landing at Leith in August 1822, whereupon Sir Walter toasted the King's health with the finest Highland whisky he could procure. The King loved the whisky, for its flavour was unlike any he had previously tried. There followed a glittering nationalist pageant in Edinburgh with feasts and engagements lasting many days, in the course of which the King frequently demanded his newly-discovered favourite Highland whisky. Supplies quickly ran out.

Elizabeth Grant of Rothiemurchas records the events in her *Memoirs of a Highland Lady*¹, "Lord Conyngham, the Chamberlain, was looking everywhere for pure Glenlivet whisky; the King drank nothing else. It was not to be had out of the Highlands. My father sent word to me to empty my pet bin, where was whisky long in wood, mild as milk, and the true contraband goût (flavour) in it". Sir Walter Scott had procured the best whisky he could find for the King's first toast in Scotland, from the Glenlivet district in the Highlands above the river Spey. It happened to be illicit or contraband whisky, produced in highland bothies hidden in the hills to evade taxation and confiscation by the excise officers.

The best whisky was illicit, from stills hidden in remote glens

The essential ingredients for making fine malt whisky—barley, peat and a copious supply of fresh, clean water—were all abundant at Glenlivet. The fertile valley of the river Spey below provided good barley; the hills above were layered with peat, an unlimited supply of free fuel, and the water that flows from the peak of Ben Rinnies down the river Livet is ideal for making whisky—cold, soft, pure melted snow.

Contraband Highland whisky

One family of contraband whisky makers is depicted in *The Illicit Highland Whisky Still* by Sir Edwin Landseer, 1829 (Figure 1). There are good reasons why the whisky of Glenlivet had the highest reputation. First, good whisky cannot be made in a hurry, and the glen's remoteness made it very difficult to police. Excise officers could be spotted miles away, allowing plenty of time to move the equipment and product. The smugglers' stills were, of necessity, small and portable, typically around 2–5 gallons capacity. They had to be carried into the hills and needed to be easily concealed so small copper stills were used. Landseer captures the romance of secret illicit distillation in a bothy hidden high in the hills above Glenlivet. In the detail of his painting can be seen the smuggler's equipment, the authenticity of which suggests that he painted it from life.



Figure 1. *The Illicit Highland Whisky Still*, by Sir Edwin Landseer, 1829. A family engaged in illicit distillation in a bothy in the hills, high above Glenlivet. Reproduced by courtesy of the Victoria and Albert Museum, London

Whisky distillation using small pot stills over an open fire has to be a slow process, and the smugglers had plenty of time. We now know that the copper of the still and condenser acts as a catalyst to convert the alcoholic vapours into congeners such as esters and aldehydes, the fruit flavours and delicate fragrances that are characteristic of fine malt whiskies. Small pot stills run slowly provide longer and greater exposure to copper and therefore stimulate these reactions, resulting in a richly-flavoured spirit, brimming with floral, fruity character. By comparison, the licensed distillers in the lowland cities operated large stills, which were run fast to produce spirit cheaply and in bulk, much like vodka today.

The contrast between licensed Lowland and contraband Highland whiskies could not

have been starker, which is why Scott chose Highland whisky for the King's toast, and why Grant selected her finest Glenlivet whisky, with the "true contraband *goût* (flavour)", to send to Holyrood. Herein lies the distinction, which some assert continues to this day, between the flavour styles of Highland and Lowland Scotch malt whiskies.

The famous Victorian whisky writer, Alfred Barnard², distinguished between Highland and Lowland malt whiskies, and noted the conversion of some Lowland distilleries to the more popular Highland style. For example, he describes the Lowland Bankier distillery, built in 1829, as follows: "The whisky is now made on North Highland principles and, although a Lowland distillery, the quality of the spirit appears to us to be of a most

pronounced and excellent Highland style of whisky".

Diversity of flavour

The rich variety of flavours in single malt Scotch whisky continues to this day, and indeed is now more diverse due to the variable use of peat in drying the barley and different types of cask for maturation. Highland and Island whiskies were originally of a smoky style, because peat was the main fuel used for drying the malted barley. It was, and still is, abundant on Highland moors and, of course, it was free—all you had to do was cut and dry it, and labour was cheap. It explains why a popular term for Highland whisky at the time was "peat reek". That changed when

Queen Victoria and Prince Albert bought and rebuilt Balmoral as their summer residence, initiating the extension of the railways into the Highlands. It now became practicable for late-Victorian distillers to use coal and coke in their kilns, and many (not all) lightened the character of their whiskies by removing the smoky/peaty flavour. Some, such as Auchentoshan and Glengoyne, moved to the furthest extreme on the smoke scale, by removing peat altogether, drying their barley with hot air. Most distillers now produce "lightly peated" malts, while some continue the tradition of heavily-peated malt, notably on Islay.

The whisky industry flourished during Queen Victoria's reign, partly due to all things Scottish becoming fashionable in royal society. It was also helped by a plague of Phylloxera aphids which, from 1880 onwards, devastated the vineyards of France, particularly those in Cognac, such that cognac became unavailable and brandy drinkers turned to Scotch whisky.

Blended Scotch whisky

The quality and consistency of most malt whisky was unreliable, however, and with the introduction of the continuous patent still in the mid-19th century, the blenders took over. The famous whisky merchant Andrew Usher was Glenlivet's first distributor, and he introduced it to London society in 1844 as "by far the purest and finest spirit made in any part of these dominions". When Usher pioneered blended whiskies in 1853, his first successful brand had Glenlivet whisky at its heart and was called Usher's Old Vatted Glenlivet. It sold well in London, at a premium to other whiskies and was soon being exported to India, Australia and throughout the British Empire. Charles Dickens was another convert to Glenlivet, recommending a rare old specimen to a friend in 1852. Robert Louis Stevenson also included it in his famous 1887 poem, "The king o' drinks, as I conceive it, Talisker, Isla, or Glenlivit (sic)". "Conceive it" and "Glenlivit" perhaps rhyme better after consumption.

The delicious feature of single malt whiskies is that their flavours are so diverse. Usher had found that a blend of malt whiskies from different distilleries could deliver several raw flavours simultaneously, usually layered, in complex harmony. His discovery led to a number of whisky blends being launched in the latter half of the 19th century, which went on to become household names.

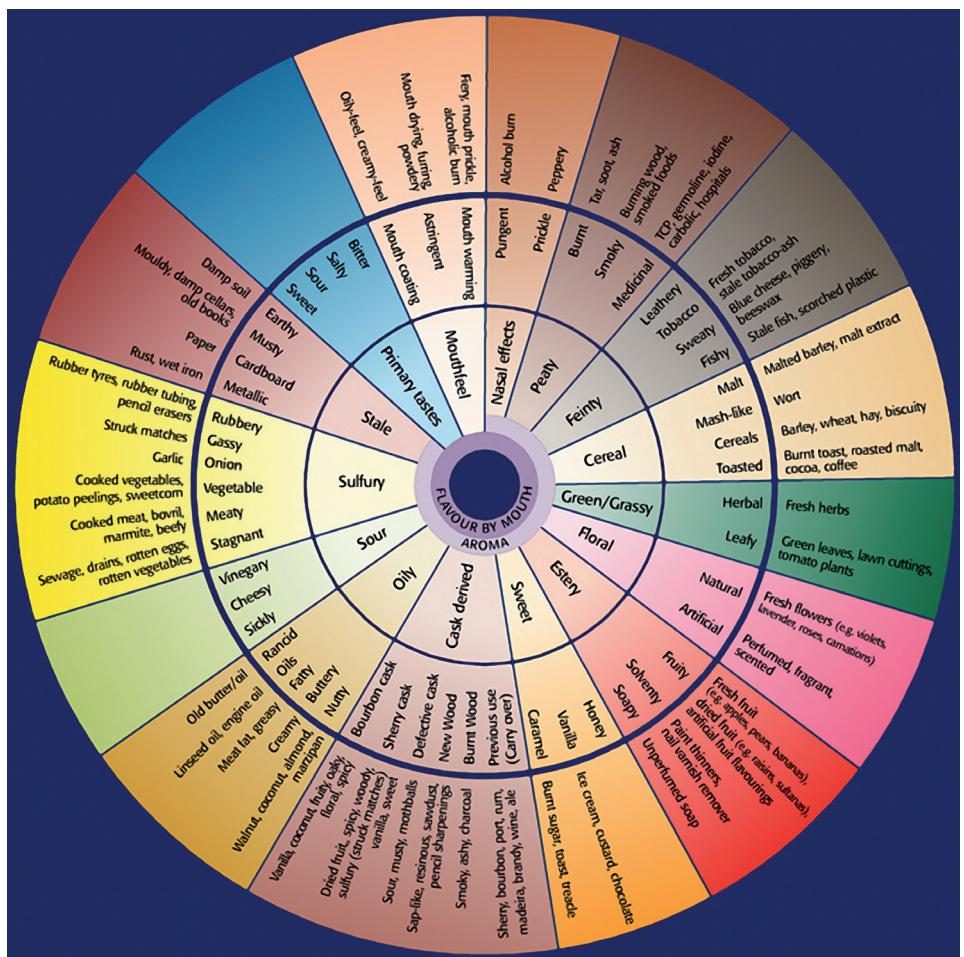


Figure 2. The Flavour Wheel of the Scotch Whisky Research Institute, Edinburgh. © The Scotch Whisky Research Institute, The Robertson Trust Building, Research Park North, Riccarton, Edinburgh. Based on Shortreed, Rickards, Swan & Burtles (1979), The flavour terminology of Scotch whisky, *Brewers' Guardian* (Nov.)

Some people argue that a fine blended Scotch whisky is greater than the sum of its component parts, often likened to an orchestra. Although this may well be true, it is the component malts that deliver the flavour character, or signature, to the top blended whiskies. Whereas a blended whisky may typically contain up to 30 different malt and grain whiskies, several producers now identify the principal single malt whisky in their blends; for example, Strathisla is the "heart" of Chivas Regal; Glenrothes is the "signature" in Cutty Sark; Famous Grouse is built upon Highland Park and Macallan; Johnnie Walker is closely identified with Mortlach. For the first time, malt whiskies were classified by their flavour, the blender's art being to choose a malt, or to

an historic measure of their desirability for blending.

Single malt whisky

For more than a hundred years, blended Scotch whiskies held sway, and indeed still do account for the bulk of all Scotch whisky sold today. But a blended whisky, however famous its brand name, is only a recipe. It has no provenance, and little heritage, other than the originator's name or brand. Today, single malt whisky is the strongest growth category of Scotch whiskies and production cannot keep up with demand. Closed distilleries are being reopened and new distilleries are being built. Whisky festivals flourish across Scotland, and throughout the world, and whisky magazines and websites abound. Every year, Scotland plays host to thousands of whisky tourists eager to follow the malt whisky trail and trace the provenance of their favourite malts. Scotland's "Homecoming" festival has designated May

2009 to be "Whisky Month". For it is the distinctive flavour character, provenance and heritage that characterise Scotch malt whiskies and differentiate them from all other drinks.

Many writers vie to describe the flavours of single malt whiskies, and internet sites devoted to this passion are legion. But this was not always the case. Barnard² described the plant and equipment used at the distilleries he visited, but he very seldom mentioned the style or quality of the whisky. Jackson⁴ was one of the first to describe the flavour of single malts, and he was quickly followed by others (Arthur⁵, MacLean³, Milroy⁶, Nown⁷, Tucek and Lamond⁸).

Flavour vocabulary

Building on the popularity of Jackson's work, Lapointe and Legendre⁹ decided to classify malt whiskies by flavour on the basis of Jackson's adjectives. His language is very rich and diverse, and they chose to discard any words he used for fewer than five malts, resulting in a core flavour vocabulary of just 68 words. They then classified 109 malt whiskies on the presence or absence of these 68 words in Jackson's tasting notes.

I reproduced their classification, which was partly aimed at defining contiguous whisky regions within Scotland, much as France has defined wine appellations. However, it quickly became evident that there is no *terroire* associated with the making of whisky today, despite the historical distinction between Highland and Lowland whiskies identified by Elizabeth Grant in 1822. Also, I was concerned at the potential loss of information in discarding sparse adjectives, and by the fact that no attempt was made to account for the intensity of the flavours. The reliance on Jackson, a single author source, seemed a potential bias in favour of his preferences, which were directed already at arriving at his personal score for the quality of each whisky, marked out of 100.

I therefore resolved to classify on a broader basis using the descriptions of malt whiskies by a panel of writers and also accounting for the intensity of the flavours. In 1979, a group of sensory analysts devised a language of whisky at the Pentlands Scotch Whisky Research Institute. They produced a whisky wheel, which has since been refined by their successor, the Scotch Whisky Research Institute (Figure 2). This diagram is not very user-friendly, dominated as it is by chemical terminology, and this led John Lamond¹⁰, working with the Aberlour Distillery, to publish the simplified

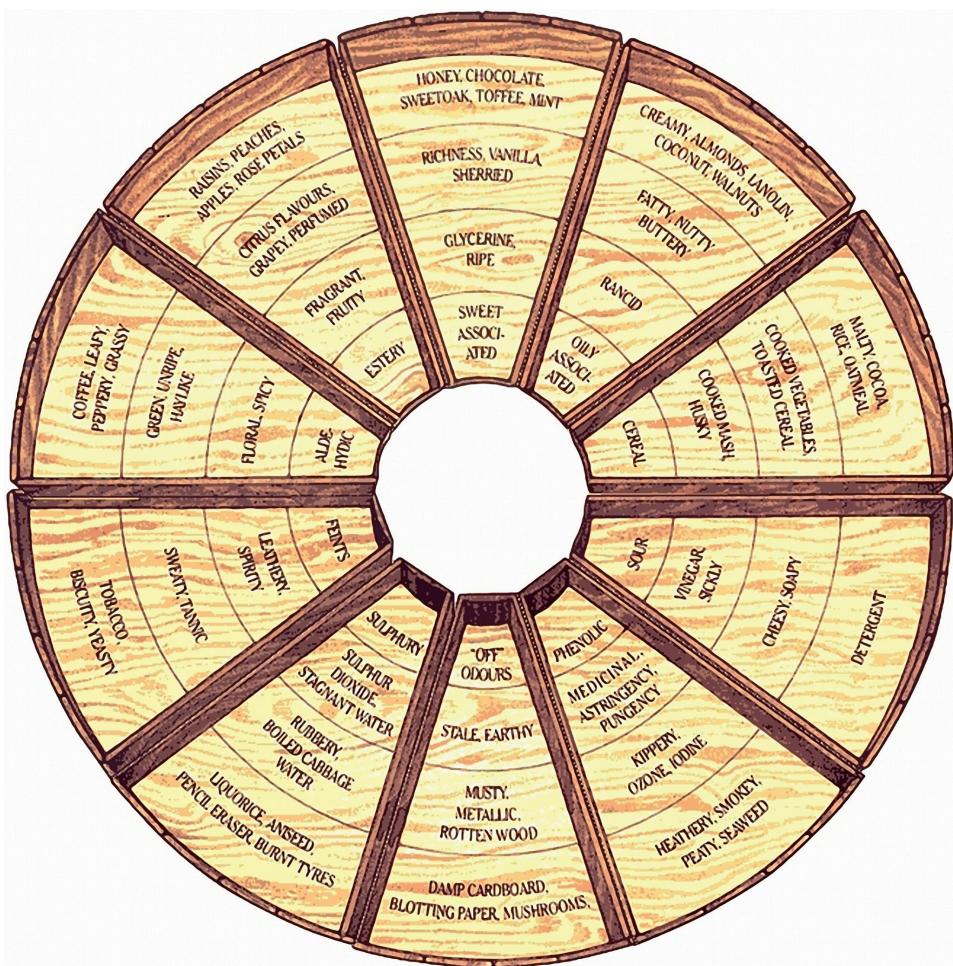


Figure 3. Aberlour Tasting Wheel. Reproduced by kind permission of John Lamond

Aberlour Tasting Wheel (Figure 3). MacLean³ also re-drew the Pentlands wheel with three tiers, arranged around a hub of eight cardinal aromatic groups (Figure 4), with a separate designation of nine flavours and mouth-feel categories. These were "sweet", "sour", "salty", "bitter", "warming", "cooling", "prickly", "viscous" and "cloying".

The first stage was, therefore, to compile a more comprehensive vocabulary of words used to describe the flavour of single malt whiskies. To maintain a level standard, the principal malt whisky produced at each operational distillery in Scotland was selected for profiling, and tasting notes were collected from a panel of eight writers. This provided a whisky flavour vocabulary of around 450 words, which has since been enlarged. The vocabulary was next categorised by MacLean's cardinal groups of aromas and flavours. In this exercise, some categories were over-represented whereas others were under-represented. This can be explained by the fact that off-flavours such as "sulphury", "stale", "sour" and "feinty" are

seldom evident in proprietary malts because faulty casks exhibiting off-flavours are rejected before bottling.

The whisky flavour wheel was further developed into a spider chart (Figure 5) and a flavour map¹¹ (Figure 6). The spider chart is compact, attractive in use, and does contain actual data; its only defect is that a point on a flavour spoke can fail to show if the adjacent scores are both zero, but this seldom happens. The flavour map appears to have been constructed intuitively, having values for "smoky", "rich", "delicate" and "light". The use of orthogonal axes labelled "light" and "delicate" appears contradictory, and some of the malts seem oddly placed; for example not many whisky enthusiasts would think of Ardbeg and Springbank as "light", while Lagavulin and Talisker are contrastingly shown as "rich" on the x-axis. All of these diagrammatic aides seek to clarify the vocabulary of flavour, and, where applied to individual malt whiskies, to augment the tasting notes. There is no attempt at further analysis.

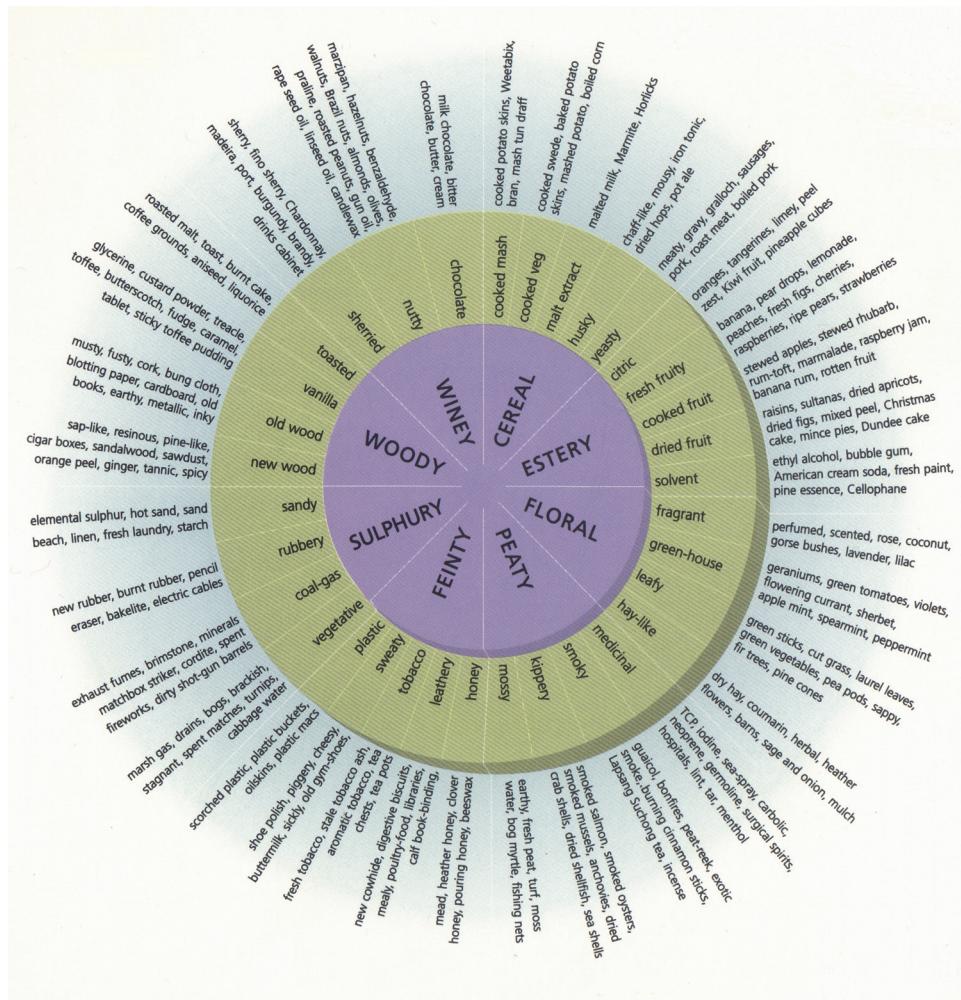


Figure 4. MacLean's Tasting Wheel. Reproduced by kind permission of Charles MacLean

Cardinal flavours

We have, however, undertaken further analysis to group malt whiskies into clusters such that the malts within each cluster taste broadly similar. In MacLean's cardinal groups

the "peaty" category includes both "smoky" and "medicinal" descriptors, the latter being more associated with Islay where the peat is decomposed forest, as compared with heather peat elsewhere. By contrast, whiskies from Orkney, Mull and Speyside can be equally smoky but display less medicinal character. It was therefore decided to adopt two flavour groups, "smoky" and "medicinal", with the latter including "salty" and "bitter" flavour descriptors. The "woody" group is not easily expressed in the vocabulary, which more frequently relies on terms such as "spicy" for active casks, "vanilla" relating to

American bourbon casks used in maturation and "honey" for maturation in European oak casks. The "body" of the whisky, while not a flavour as such, occurs frequently despite not featuring in MacLean's descriptors; similarly "sweet" and "dry" are often used. The outcome of the vocabulary review was to settle on 12 cardinal flavours as enumerated in the flavour dictionary in Wishart¹². They are "body", "sweetness", "smoky", "medicinal", "tobacco", "honey", "spicy", "winey", "nutty", "malty", "fruity" and "floral".

The principal malts from all operational distilleries were next rated for these 12 cardinal flavours on a 5-point scale, according to the intensity of each flavour, as recorded by the panel of whisky writers: "not present", "low hint", "medium note", "definite note" and "pronounced flavour". Figure 7 shows the resulting flavour profile for Highland Park 12 years old. The malts were then classified by cluster analysis into 10 clusters of whiskies that taste similar, as reported by Wishart¹³ (see box).

Such an analysis is, however, only as reliable as the cardinal flavour intensity ratings, which had been subjectively determined from tasting notes. The results were then circulated to the industry and many helpful comments were received, pointing out malts that appeared to be wrongly assigned to the clusters. These errors could be traced back to the data, where, for instance, the absence of smokiness in Auchentoshan and Glenkinchie whiskies had been incorrectly graded. The data were reviewed, a second classification and then a third were circulated prior to publication in Wishart¹². The publisher wished to include an authoritative industry review and logo, and this was agreed by the Scotch Whisky Heritage Centre provided that all its members, which comprise the Scotch whisky producers, approved. Their written approval was thankfully forthcoming, and it can, therefore, be claimed that the classification has the full support of the Scotch Whisky Industry.

The objective of the cluster analysis is to group whiskies that have similar flavour and to find nearest neighbours based on their flavour

Macallan Nosing Charts

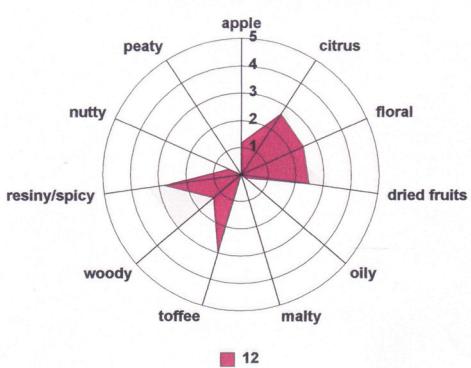


Figure 5. Macallan Spider Chart. Nosing values for Macallan Sherry Cask 12 years old. Reproduced courtesy of Highland Distillers Ltd

Classification by flavour

The cluster analysis seeks to minimise the within-clusters sum of squares for a given number of k clusters, $\min E = \sum_k \sum_{j \in k} (x_{ij} - \mu_{kj})^2$, where x_{ij} is the value of flavour j for malt i in cluster k , and μ_{kj} is the mean of flavour j in cluster k . It was obtained using the FocalPoint k -means procedure in Clustan¹⁴ with a serial re-ordering of the resulting tree to sequence most efficiently the clusters labelled A–J in the flavour spectrum (Figure 9).

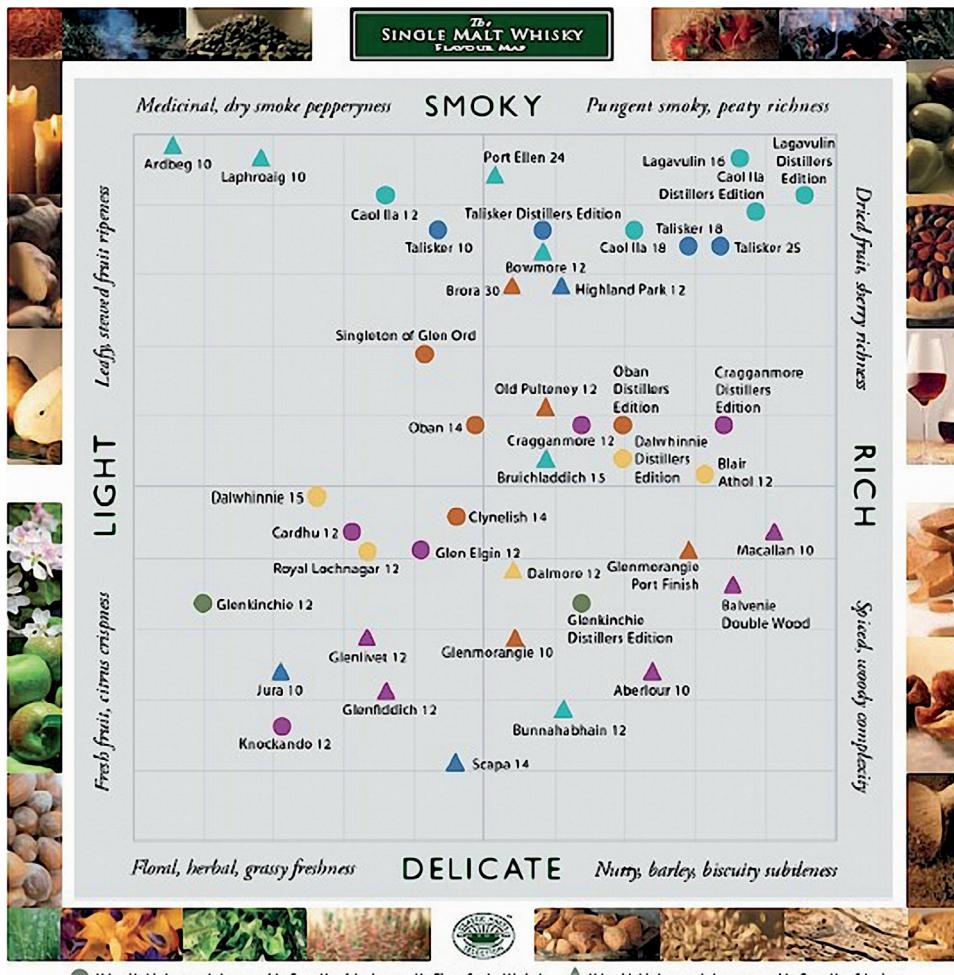


Figure 6. Diageo Single Malt Whisky Flavour Map. Reproduced courtesy of Diageo plc



Figure 7. Flavour profile for Highland Park 12 years old.

profiles. However, all perceptions are subjective in this field, and it is indeed quite surprising how whisky experts differ in rating the "quality" of the same malt, let alone how its flavour is described (see *Whisky Magazine*).

Flavour chart

Having obtained a classification that was fully supported by the industry, and which was later extended to around 200 malts, the next step was to construct a flavour map from the data. Principal component analysis was applied to 185 single malts rated on 12 cardinal flavours, to project a 12-dimensional scatter on to its principal components. To display the scatter in two dimensions clearly constitutes an oversimplification of the variability in the data. However, 46% of the variance was explained by the first two components, and the resulting scatter is shown in Figure 8. This can be described as the best two-dimensional view of the flavour profiles for 185 malts.

The first component is easily interpreted as ranging from "smoky" and "medicinal" to "fruity", "sweet", "honeyed" and "winey". The second component differentiates "light"/"delicate" from "full-bodied"/"rich". The third component, accounting for 10% of the variance, had high weights for "tobacco", "malty" and "herbal", and might be interpreted as differentiating young whiskies that display cereal/malty notes, feints and aldehydes yet to be absorbed or modified during cask maturation. The fourth component, accounting for 9% of the variation, scored high on "spicy" and low on "sweet", perhaps relating to the type of cask used and its freshness and activity.

Summary

Whisky Classified is an example of a product segmentation used in marketing, where the goal is to define niche product segments that each appeal to different consumer groups. Those that have found a malt whisky they like can experiment with products in the same or neighbouring clusters. They do not need to taste the whole range to discover their preferences. A common marketing tool is the suggestion "If you like that, then try this ...". The cluster analysis identifies nearest neighbours that flag up malts of similar taste.

Malt whisky novices often start near the lower centre of the flavour chart (Figure 8), with delicate light and fresh malts such as Glenfiddich, Auchentoshan and Glengoyne. Seasoned malt enthusiasts, by contrast, tend to migrate to the two extremes, either to the

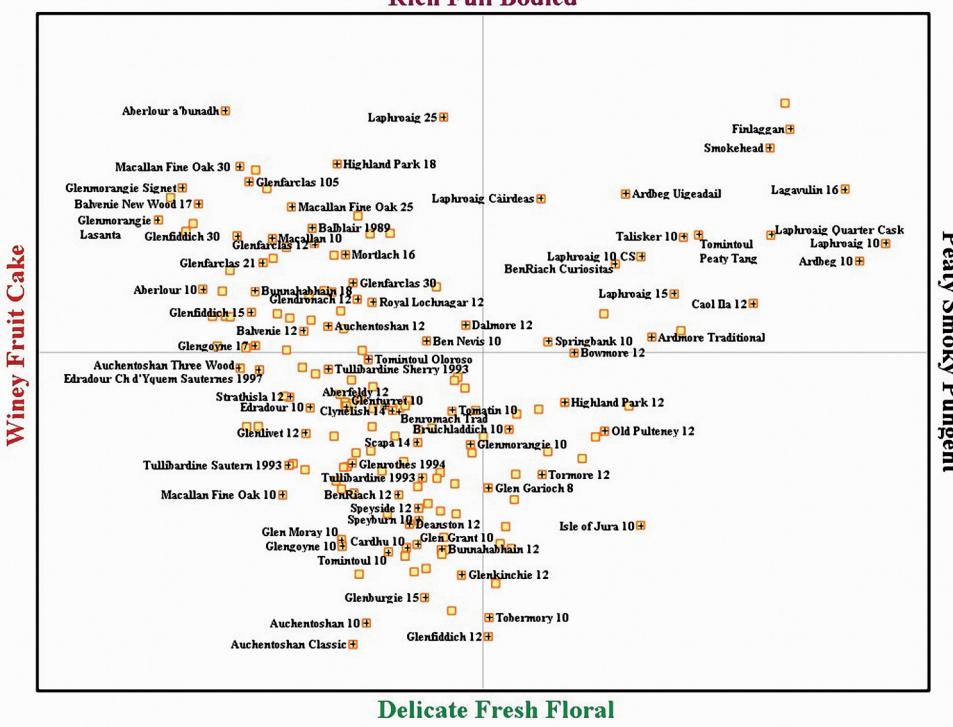


Figure 8. Flavour chart for Whisky Classified, first two principal components displayed from analysis of 185 malts. The chart accounts for 46% of the total variance on 12 cardinal flavour dimensions

rich, full-bodied intensely winey malts to the upper left, or to the heavily peaty/smoky malts to the right. The trend from lower centre to upper left in Figure 8 is strongly associated with the types of oak cask used for maturation or finishing, the length of maturation and how active were the casks in contributing wood and wine or bourbon flavours.

This classification is also helpful when choosing a representative range of malts, for example in planning a whisky tasting. A selection of, say, six malts can be made from the 6-cluster partition of the flavour spectrum (Figure 9) so that a good contrast of flavour styles is obtained. I always use this approach when planning a malt whisky tasting for a small group of people.

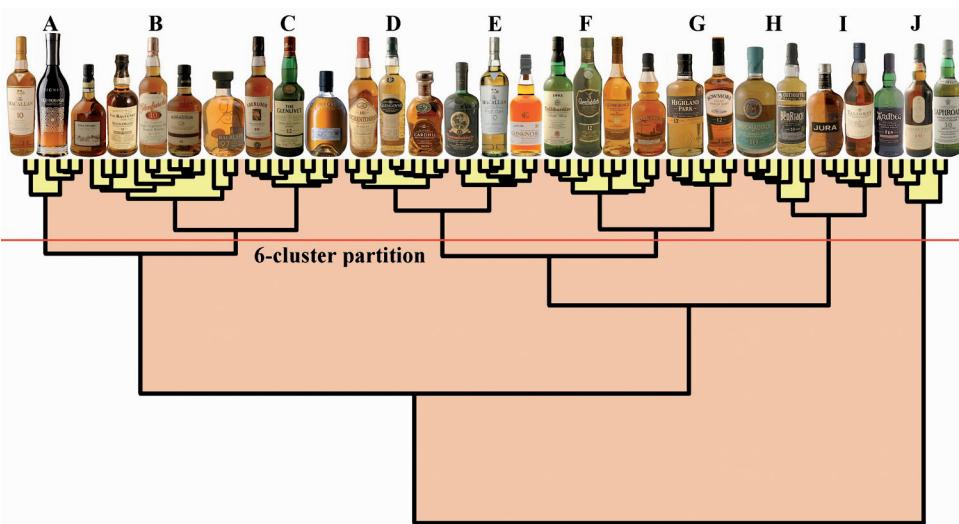


Figure 9. Malt whisky flavour spectrum. Hierarchical classification of the principal single malt whiskies of Scotland on the basis of flavour profiles, *k*-means analysis for ten clusters serialised A–J

Readers of *Significance* will have the opportunity to test my classification at this year's Royal Statistical Society Conference in Edinburgh. It will include a technical session on the statistical material, followed by a practical tasting of around 30 malts that have kindly been contributed by the whisky producers. It will also be presented to the industry at this year's World Whisky Conference in London.

Scotch whisky has become Scotland's largest export, and, despite the present worldwide recession, it continues to expand and flourish. My classification by flavour is a small contribution to helping new malt whisky consumers navigate their way around this delicious and compelling subject.

References

1. Grant, E. (1897) *Memoirs of a Highland Lady*, edited by Lady Strachey. Edinburgh: R&R Clarke.
 2. Barnard, A. (1887) [2000] *The Whisky Distilleries of the United Kingdom*. Reprinted in 2000, Osnabrück: Rasch.
 3. MacLean, C. (1997) *Malt Whisky*. London: Mitchell Beazley.
 4. Jackson, M. (1989) *Malt Whisky Companion*, London: Dorling Kindersley.
 5. Arthur, H. (1997) *The Single Malt Whisky Companion: A Connoisseur's Guide*. London: Apple Press.
 6. Milroy, W. (1995) *The Malt Whisky Almanac*. Glasgow: Neil Wilson Publishing.
 7. Nown, G. (1997) *Malt Whisky: A Comprehensive Guide for both Novice and Connoisseur*. London: Salamander.
 8. Tucek, R. and Lamond, J. (1997) *The Malt Whisky File*. Edinburgh: Canongate Books.
 9. Lapointe, F.-J. and Legendre, P. (1994) A Classification of Pure Malt Scotch Whiskies. *Applied Statistics*, 43, 237–257.
 10. Lamond, J. (1980) Aberlour Tasting Wheel. Aberlour Distillery.
 11. Broom, D. (2007) *The Single Malt Whisky Flavour Map*, London: Diageo.
 12. Wishart, D. (2002), *Whisky Classified: Choosing Single Malts by Flavour*. London: Pavilion Books.
 13. Wishart, D. (2000) Classification of Single Malt Whiskies, Proceedings of the IFCS-2000, Namur, Belgium. In *Data Analysis and Classification Methods* (eds: H. A. L. Kiers, J. P. Rasson, P. J. F. Groenen and M. Schader), pp. 89–94. Berlin: Springer.
 14. Wishart, D. (2006) ClustanGraphics8, Clustan Ltd, Edinburgh (available at www.clustan.com).

David Wishart is a Fellow of the School of Management, University of St Andrews, and author of *Whisky Classified: Choosing Single Malts by Flavour*.