Creating a Winning Candle Fragrance—from Brief to Manufacture

Addressing the three "C's" of formulation: cost, compatibility and cold throw—plus a candle fragrance glossary

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"Air Care—US," a Euromonitor report released last winter, detailed this $2 billion-plus market, which grew 6% between 2004 and 2005. Within this segment, candles jumped 30%—more than any other category—to sales of $265 million. (For details on the future of air care, see **Air Care: 2005–2010, p 32**.)

No surprise, candle fragrances are the bread and butter of many midsized fragrance houses, and many considerations need to be taken into account to create a winning submission. In my career, I have encountered many fragrance briefs for candles, which, to say the least, present the perfumer with many challenges. Some typical customer comments:

- Example 1: "We love that new duplication you made of *DKNY Red Delicious*. Can you make it for a candle at $6.00 per pound?"
- Example 2: "I tried the sandalwood musk fragrance you sent, but I can't smell it when I put it in the candle."
- Example 3: "The Herbal Essences-type fragrance I use in my shampoo bleeds out when I try it in a candle."

Indeed, most of the important issues that come up when creating candles can be summed up with three "C's": cost, compatibility and cold throw.

Cost

In Example 1, a fine fragrance that may have a raw material cost of $20 per pound presents price limitations in candle formulations. Appreciable amounts of expensive essential oils are virtually off limits to candle scents, not to mention the other absolutes and modern aroma chemicals found in the new designer fragrances. Simply diluting a fine fragrance composition won't cut it either, as candle manufacturers demand high-impact scents to attract consumers who base their purchase decisions on the smell of the candle right off the shelf, i.e. cold throw.

Ingredient alternatives: So what can one do? A good knowledge of essential oil compositions helps, allowing the perfumer to choose lower cost substitutes. For example, instead of using 10% lavender oil, I have used lavandin oil on occasion, or a mixture of both materials. The amount of patchouli oil used can

be hedged by incorporating guaiacwood, cedarwood and Gurjam balsam oils. Then, of course, there are a myriad of cost-efficient synthetic aroma chemicals, which can be used to replace or enhance expensive oils, resulting in more bang for the buck. The perfumer has a great option, for example, in creating a sandalwood note by using a combination of synthetics to achieve the desired effect.

In addition, popular staples of fine fragrance such as bergamot can be replaced with low cost "keys" or bases. Most fragrance houses have standard bases for ylang ylang, rose, jasmine, and orange flower, which are pre-made in large quantities so as not to become a production burden when it comes time to manufacture. Some more unique accords such as mandarin can often be replicated by substituting a less expensive essential oil, enhanced with touches of high impact aroma chemicals. In the case of mandarin, one can employ orange oil with a small amount of mandarin aldehyde.

Cold Throw

While formulating a fragrance for candle use, one must also keep in mind the need for a strong "cold throw." This is because many consumers base their purchase decision by smelling the candle right off the shelf. The candle may burn and disperse scent wonderfully, but that won't mean anything if it never gets bought! To increase cold throw, I often automatically boost top notes of citrus, aldehydes and greens, while decreasing the background notes of musks, woods and amber. When reformulating a fragrance that by nature "lays low," such as the sandalwood musk fragrance presented in Example 2, many of the woody and musk chemicals (ex: Galaxolide (IFF), Hedione (Firmenich) and benzyl salicylate) can be halved in order to allow the more fruity and floral accords to

Glossary of Common Candle Fragrance Solvents

Benzyl benzoate: A common fragrance and flavor solvent, very compatible with most waxes, though it can cause sooting problems while the candle is burning, if used in excess. Benzyl benzoate is also on the EU allergen list, which generally does not affect the candle industry as it is not used on the skin, but may be a concern to some manufacturers.

Diethyl phthalate (DEP): A commonly used solvent compatible with most wax blends, which can cause fragrance bleeding if used in excess, and has been the subject of recent media attention as an endocrine disruptor (though its safety has been affirmed by RIFM and IFRA). (To view IFRA's DEP statement, visit *www.perfumerflavorist.com/regulatory* and click on IFRA DEP Position).

Dioctyl adipate (DOA): This is a good heavy co-solvent for candle fragrances, helping bridge differences with wax in certain rich or spicy-type fragrances. The price of DOA is comparable to DEP and benzyl benzoate, and therefore it is more commonly used of late.

Dipropylene glycol (DPG): A candle fragrance no-no! DPG is commonly used in personal care applications, but is not soluble with wax, and will cause fragrance bleeding. Often this issue is discovered when a customer attempts to use the same fragrance they purchase for their personal care product in a candle application.

Hercolyn D: This synthetic resin (a reacted and "deodorized" wood rosin mixture) acts both as a solvent and (more commonly) as a "fixative" for added fragrance longevity and to help solve "high-flame" burn characteristics. This material may also help with the fragrance warm throw as the candle is burned.

Iso paraffinic mixtures: These are synthetic and uniform saturated isoparaffinic fluids derived from crude oil, which can be added for "lift" and increased burn rate (ex: Isopar H). They can also solve certain solubility difficulties with the candle base (ex: Isopar M). These mixtures are not good perfume material solvents, so usage can be limited.

Iso propyl myristate/iso propyl palmitate: Used mostly in lotion applications, but also in some candle fragrances to help bridge compatibility between waxes and certain fragrance types.

Low-odor mineral spirits: Inexpensive solvents compatible with wax that can add lift and help solve "low-flame" burn characteristics. These spirits can be very limited with certain polar-type fragrances.

Mineral oils: These are used to soften wax blends and achieve mottling effects. Mineral oils are primarily used in clear gel candle fragrances, which are making a comeback after several years. These oils are not soluble with many types of fragrances.

come through. Adding aldehydes and small amounts of leafy green chemical such as *cis*-3-hexenol can help boost those background accords.

Compatibility

Of course, no matter how wonderful your fragrance, it is imperative that it is compatible with the customer's particular type of candle wax. The fragrance can also affect the candle in other ways; there are issues of discoloration, wick compatibility, flash point, burn rate and flame throw to deal with.

In Example 3, a fragrance created for a water-based product like shampoo most likely contained glycols, which are not compatible with wax and will bleed out. A good knowledge of typical fragrance carriers can solve most compatibility problems (see **Glossary of Common Candle Fragrance Solvents**). Often I have found that a combination of solvents is usually best to achieve optimal performance, based on wax properties and fragrance characteristics. Any one solvent in excess may cause compatibility and burning issues.

Discoloration

This is another issue when it comes to candle fragrances. It is well known that many of the polar sweet aroma chemicals, such as vanillin and maltol, will discolor a product, and in some cases, affect the metal wicks that are utilized. In addition, the crystalline nature of these important chemicals can result in fragrance precipitation if used in excess.

In some cases, these items must be removed from the formulation completely. But another option is to use related chemicals, which may exhibit the same problems, but can be used at much lower levels so as to minimize this issue. For example, ethyl vanillin and ethyl maltol can be substituted for vanillin and maltol, achieving a similar effect at only one-third the level. Another popular replacement chemical is vanitrope, which is a sweet note that is not only stable and non-discoloring, but also is strong enough to use at only a level of one-quarter to one-eighth the amount of vanillin. A further enhancement could be to add a touch of butyric acid or a similar chemical to add a buttery cake accord that may be lost as a result of the vanillin reduction.

Warm Throw

How a candle performs when burning, or its "warm throw," is also vital to creating a winning candle

fragrance. One also wants a candle that burns at an even rate, without welling (caused by burning too fast) or sooting. These properties are often dependent on the type of fragrance; spicy and heavy floral fragrances will generally burn slower, while lighter, fruitier fragrances will burn quickly. A proper balance of solvents, applied in various proportions, will help solve most of these problems, increasing or decreasing lift and burn rates as needed. A good applications department, preferably armed with the customer's own wax, and evaluation of burning candles in a sensory room, will be helpful in figuring out the optimal formula. (See **Glossary of Common Candle Fragrance Solvents** for more comments.)

Paraffin Waxes vs. Soy Waxes

There has been a great increase in the use of soy-based waxes in recent years. There are several reasons for this. Soy waxes are obtained from natural sources, which are a selling point for many candle manufacturers and their customers. These waxes have the advantage of being biodegradable, and are generally cleaner burning. In addition, soy is becoming a cheaper alternative to paraffin waxes, which are petroleum-based and have been affected by the price increases of crude oil.

However, soy waxes present further challenges for perfumers. In general, fragrances do not diffuse as well in soy wax as in paraffin wax. Soy waxes are made of large, nonvolatile molecules such as triglycerides and fatty acids that do not mix as well and can "trap" volatile fragrance components.

So, when working with soy wax, even more experimentation is required. One must test various solvents and top note-boosting chemicals to arrive at a fragrance that is suitable, while still providing the desired lift. In general, the more homogenous a fragrance is with the wax, whether it is soy or paraffin, the better the candle will perform in terms of burning and throw.

Manufacturing Tips

There are also some things that can be done to improve compatibility when adding a fragrance to a melted candle wax. It has been observed that using a lower temperature when melting wax (just above melting point) will help increase the fragrance cold throw in soy candles. Also, in the case of paraffin waxes, certain specialty waxes or polymers such as Vybar (Baker Hughes) can be added along with the fragrance. These additives help bridge the differences between the aroma chemicals and the wax, and allow the candle to support higher fragrance levels, while decreasing compatibility issues such as fragrance bleeding and discoloration.

A Week of Sunshine: a Case Study in Candle Fragrance Creation

So let's put this all together with a hypothetical project: A customer has a fragrance that it is using for a hand lotion called *Vanilla Sunshine*, with a citrus top note, transparent floral heart and sweet creamy background. The customer wants to extend its brand by putting the scent in a candle application.

Day 1

First thing I see is that the lotion scent is loaded with 50% DPG. Let's substitute that with 25% DEP and 25% benzyl benzoate. The price the customer wants to pay is $6.50 per pound, as opposed to the $10.00 per pound it's currently spending for the lotion fragrance. I see that this scent uses real bergamot oil, so I can sub it with a key.

The fragrance also contains tangerine; let's replace it for now with Brazilian orange oil. I also note the presence of expensive lemon oil typically employed for skin sensitivity issues; I can replace that with our stock California lemon oil. The Calone in there can be cut in half to save more money while retaining enough to impart that fresh floral marine accord. And why the heck does the lotion fragrance contain vetivert oil? I can just substitute patchouli oil. Following a little more rebalancing of Lilial (Givaudan), benzyl acetate and hexyl cinnamic aldheyde, I send out the first submission.

Day 2

The submission comes back. The fragrance is bleeding out of the candle. I suppose that 20% coumarone, vanillin and ethyl vanillin was too much. OK, I'll try a combination of 5% ethyl vanillin, add 1% vanitrope, cut the coumarin in half and take out the vanillin completely. We shall see how that works. I request that the customer send us some of its candle wax.

Day 3

"We need a new version," says the customer. "The fragrance isn't bleeding anymore, but it seems the metal candle wicks are being discolored now by something (*must* be the fragrance!). Plus, can you make the fragrance water-white?"

I take another look at the formula; it contains small amounts of citral and maltol that are the likely culprits, so I'll take them out. Plus, it's probably best to cut the ethyl vanillin down to 1% and use the more stable vanitrope at a level that I can afford. But now for the color of the fragrance itself: I'll use our decolorized orange oil, the molecularly distilled patchouli oil "light," and replace the yellowy amyl and hexyl cinnamic aldehydes with Hedione (Firmenich). In addition, that methyl anthranilate needs to go—it is no doubt causing a darkening effect.

Day 4

"We love the fragrance," says the customer, "but it burns a little too fast, and the flash point for shipping needs to be above 140 F." OK, I can reduce 10% citrus oils and light esters; that should solve this problem. I choose a 10-fold orange oil and five-fold lemon, the lightest shade I can find, so I can use less citrus oil with the same impact. I'll remove the ethyl and amyl acetates and use their heavier cousins, ethyl and amyl butyrate. Adding ~2% of Hercolyn D should help hold down the burn rate. Now that we have the customer's wax to experiment with, I am able to test out various versions before sending out "the final answer."

Day 5

"We decided to switch to soy wax," the customer tells me. "The fragrance doesn't seem to have enough cold throw now. We're sending you 5 lb of the new wax." I think it's time to go over the whole formula again. I can tweak the solvent system, add some new top notes, throw in a little more decanal and dodecanal, and take on some other suggestions from my colleagues that I may not have thought of. All this, of course, without changing the color, flash point, price target or fragrance character (remember *Vanilla Sunshine*?). After a few more experiments and a couple more evaluations, we have our winner.

Day 6

"We love it!" the customer cries. "The fragrance smells great and works wonderfully. Now—can you knock off another $0.50 from the price?"

Argh!

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Market report

Air Care: 2005–2010

Facing maturing products and flattening sales, where are the fragrance opportunities in this key category?

A report issued by Euromonitor (*www.euromonitor.com*) last winter, "Air Care—US," details a healthy, but cooling category with shifting emphases. These products are more and more popular because of increasingly busy lifestyles, which limit consumers' cleaning abilities; increased pet ownership and the resulting odors; and consumers' desire to set a relaxing, soothing mood in the home.

Slowing Category + Bright Spots

US air care sales grew just 6% between 2004 and 2005. These results were hampered in part by a dip in electric air freshener sales, which fell from a 29% growth in 2004 to a 6% growth in 2005. This can in part be explained by a dearth of high profile electric air care system launches, coupled with the switch by consumers from starter kits to refills. This overall slowdown is expected to continue, with Euromonitor citing maturing products.

On the bright side, however, candle air fresheners continued to be a popular segment, boasting 30% growth. What's interesting to note is that candle air fresheners continue to meet stiff competition from scented candles, which tend to have greater variety and aesthetic/olfactory appeal. While products such as Yankee Candle's *Electric Fragrancers* have broken into the traditional territory of brands such as Glade, there is a distinction to be made in that these and more traditional scented candle options tend not to make odor reduction claims. However, Euromonitor does note that consumers tend to find that scented candles are indeed adequate for odor masking in the home.

Reed diffusers contributed significantly to a 2005 sales gain of 7% in the arena of liquid air fresheners, a trend which is expected to continue. The continued popularity of these diffusers has less to do with fragrance than aesthetics—the reeds are "reminiscent of dried flowers in a vase," says Euromonitor—and the absence of the fire hazard concerns associated with candles. In addition, aerosol air fresheners boasted a 2% sales jump in 2005. This was primarily due to new product launches, including some products, such as *Febreze Fabric Refreshener*, that claimed odor elimination.

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Looking Ahead

Innovations have been the engine of growth in air care in recent years. Products such as *Air Wick Mobil'Air*, *Febreze Scentstories* and *Oust Portable Fan*, coupled with Glade's entry into the scented oil candles, have spurred growth, while increased claims (such as antibacterial action) have boosted the appeal of scented air care. "Overall," says Euromonitor, "constant value sales of air fresheners are expected to be flat between 2005 and 2010, as a result of increasing saturation." This means competition will be tight. The one category marked for significant growth? Liquid air fresheners. Led by reed diffusers, this category is expected to grow by 36% through 2010.