food for thought

"Food for Thought" explores the relationship between food/drink and chemical engineering processes/concepts.

WE HAVE STANDARDS

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Readers at ABET-accredited institutions may be familiar with General Engineering Program Criterion 5, which in part says that the curriculum shall contain "a culminating major engineering design experience that 1) incorporates appropriate engineering standards and multiple constraints."[1] Those of us who teach capstone design generally have little challenge in identifying problems that fully embrace the "multiple constraints" part of this criterion, but some folks struggle a bit more with the "standards." chemical engineering isn't like electrical, mechanical, or civil engineering where there are published standards that practically govern your morning tea (or at least the appropriate amperage and pressure of your electric kettle and the construction and placement of the kitchen-cabinets in which the kettle is stored!)

But what about…. the tea itself? Or the other items found in kitchens and pantries? It turns out, as with many things, it's complicated. And the standards are not uniform across foods either – tea, milk, chocolate, cheeses, condiments – all have different regionally defined standards of varying specificity. Let's have our virtual cup of tea steep for a bit while we consider the condiments on a neighboring shelf. This column is committed to active learning, so here's your assignment: I'm about to send you to your local grocery or convenience store or even your own cabinets (if you tend to have ample backup supplies). But before you go – answer a question. What's the category-name for that sauce that people put on green salads?

Cover up the next paragraph while you note these words down…I'll wait.

Did you answer "salad dressing"? Great. Now take this phrase and go to wherever is the closest spot you can see at least five different brand items that you personally identify as being in this category. What happens next is going to be fun, and it's going to be highly location-dependent. Readers in and out of the US are about to get some intriguingly different answers from each other. And here's where we come back to the idea of standards, and a cool instance of where they apply in chemical engineering.

If you're in the US, I'm willing to bet that you have returned from the store having spotted between 0-1 bottles of "salad dressing" that actually *calls itself* "salad dressing" on its label. Most of what you just saw will only say "dressing" and some will just have a title like "zesty Italian" and communicate its "salad-dressing-ness" through bottle shape, placement in the store, and the image of a green leaves and red tomatoes on the label. Despite this, they will not use the phrase "salad dressing" because legally, they cannot do so.

If you don't believe me, go look. Very little of what we understand to be "salad dressing" in the US actually is so. And "is" in this case has a specific meaning – it means that those products meet the published Standard of Identity (SoI) for those foods. SoIs clearly define in an accessible way what counts as a given food and what does not, generally based on both ingredients as well as the relative ratios of those ingredients. In the US there is a SoI for salad dressing: Code of Federal Regulations, Title 21 (Food and Drugs), Chapter 1, Subchapter B, Part 169, Subpart B, Section 169.150: Salad Dressing.[2] In general, the salad dressing standard specifies egg yolk as an emulsifier, which is where many commercially available dressings fail the standard. The "light" dressings also often fail for fat content – intentionally!

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Since food processes are chemical engineering processes, it's fair to ask a design class to consider what they can or can't do to a given food for it to still "count" as that food. It can be an excellent exercise incorporating engineering, economics, and standards/regulations to ask student teams to develop a formulation for salad dressing (or another product for which there is a SoI) that meets the standard while optimizing for materials cost and flavor. For example, I've used design of ranch-style dressing and its production process as a first-year project.* Students immediately grasp that flavor is an important design criterion, and readily accept that balancing costs and flavor is a reasonable part of design. However, it's nearly always new and a bit shocking when I ask them to verify that they've actually made "salad dressing," and for them to find the SoI and use what it says as part of their design process. I follow this with a discussion of why such standards exist. I try to make it clear that SoI are just one example of standards that students will find exist in just about any industry sector, and they should get in the habit of looking up standards for whatever products and processes they're considering designing for class** or in internships.

It's not only the US that has food-composition and purity standards – most countries and groups of countries (like the EU) also have such standards, and there are important differences from place to place. As with the US, these standards don't tend to address *every* food, but they do get many foods, particularly those of cultural importance. Standards can also serve the function of protecting heritage as well as brand advantage – for example, only sparkling wines created out of a defined set of grapes by a defined process within a delineated area of France may be called "Champagne".[3] This standard is more universally recognized than many others – for example, in the US it is fine to sell a domestically produced "feta cheese" while cheese labeled "feta" in the EU must come from Greece.[4] This can also be a good topic to bring into design class, as it's fertile ground for discussion of how engineering decisions intersect with culture, policy, ethics, and standards all at once.

Now that it's had a chance to steep, let's return to your tea. In the US you'll find there is no SoI for "tea"; so as long as the ingredients are clearly and honestly labeled, one can sell just about anything in the US using that designation. It's a little more complex if you want to put a splash of milk into your tea because that *does* have a SoI, defining it as sourced from a cow.[5] I get milk direct from a local farm, which means it ironically doesn't *count* as "whole milk" because it may or may not have the SoI-specified solids and fat content. Grocery store "whole milk" is generally separated and then reblended to ensure it hits the standard. If you would prefer to go plant-based with your milk, things get even *more* complex. As of the writing of this column, there is a bill presented to the US House of Representatives that would tighten the SoI for "milk" to disallow the term's use on beverages like almond milk.[6] This is despite the fact that "almond milk" has existed and gone by that name for at least 700 years, possibly much longer. A recipe for almond milk is included in the ca 1393 book *Le Ménagier de Paris*.[7] (This is a book all about running a household in France in the 1300's; besides recipes, it also explains how to train hawks for falconry.) Would you like a sweetener in your tea as well? That could be an entire Food For Thought column. The bottom line is that food identity is a rich area for student learning – one in which students can rigorously engage with standards as well as cultural, ethical, and political concerns, and other design constraints while considering the production of a product. And as chemical engineering educators, that really *is* our cup of tea!

* Send me an email at mvigeant@bucknell.edu if you want this assignment; it was originally designed as a 3-week class-and-lab intro to ChemE, but has been adapted by others to 1-credit full-semester design or even a 1-day outreach activity.

** That's come back in surprising ways, such as when one student pointed out that the "ice cream" the mass and energy balances course was making as an end-of-year celebration wasn't actually "ice cream" according to the SoI.

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