WHAT IS SENSORY ANALYSIS?

The use of *people* as *instruments* to *measure* sensory response to stimuli.
Flavor defined by Morton Meilgaard

“the term used to describe the complex interaction of taste, smell, and chemical irritation of foods in the mouth that add to its mouth-feel, such as carbonation, the burn of chili peppers, or the coolness of menthol”
Flavor is made up of:

**Basic Tastes**

**Aromatics**
- Olfactory stimulation
- Trigeminal nerve stim

**Mouthfeels**
- Chemical or physical sensations
- Astringent, dry/tannin, bite, burn, etc
What *can* we taste?

- Sweet
- Sour
- Salty
- Bitter
- *Umami*
  - response to salts of glutamic acids like MSG. Processed meats, cheeses, and soy sauce also contain glutamate

The “receptor map” is dead!

*Hanig 1901, turned over by Collings, 1974*
Can you smell sweet?

- Perception of flavor is a combination of sensory stimuli
  - Basic Tastes 5%
  - Smell is 90%
  - Touch 1% (trigem)
  - Balance is vision, hearing, etc

No, you can’t!

But, Aroma can be an Indicator of flavor
Trigeminal & Tactile Sensation

- Carbonation
  - Related to level, partial pressure
  - Pain
  - Can increase perception of bitterness

- Fullness
  - Function of residual solids
  - Dextrins and Oligosaccharides (complex sugars)

- After feel
  - Astringency
  - Pain (chili peppers)
Aroma:

- The human nose is very sensitive
  
  *More sensitive than a gas chromatograph!*

- Perception changes based on situation

- Smell with sniffs in short burst for 1-2 seconds. After this receptors become saturated and can require 20 seconds +/- to reset

- Don’t forget to exhale
The Flavor Unit

- Concept introduced by Dr. Morton Meilgaard
  - Recognized 100’s of compounds in beer
  - There are different thresholds for chemicals we can taste.
    - Example:
      - Ethanol 50 grams / Liter (50,000+ ppm)
      - S-Methyl Mercaptan 4 nanograms per Liter!!
        - $10^{-9}$ grams per Liter
        - (.0000001 ppm!)
  - Need a way to compare
    - One flavor unit = the starting threshold that a compound can be detected by the olfactory
    - Ethanol at 50 grams/Liter = 1 flavor unit
    - S-Methyl Mercaptan at 8 nanograms per Liter = 2 flavor units

Allows apples to apples comparison
BASIC TRAINING

What it comes down to is everyone who touches your beer should know how to talk about your beer!
WHO?

- Beer school for all new hires
- Brewer / Cellar / Lab
- Packaging
- Sales / Marketing
- Distributors
- Festivals / Tours / Promotions
HOW and WHEN?

- Schedule Panels as Meetings
  - Keep Consistent - same time and location
  - Goal is Regular Attendance

- Work it in so people look forward to it
  - End of Meetings
  - Shift Changes
  - Break in the Day
BEER SCHOOL

WHAT MAKES YOUR BEERS SPECIAL

- What is in it?
- Appearance / Aroma
- Taste / Flavor Characteristics / Aftertaste
- Style / Alcohol % / IBU
- Availability
- Food Pairings
YOUR BEER?

- Know the aroma and flavor characteristics of all your beers
  - MALTS
  - HOPS
  - YEASTS
  - SPICES

Whatever is in it have available for reference
Vocabulary & Recognition

- Use reference standards
  - i.e. spikes, aroma vials, malt, hops
- Repetition is the key to learning
- Don’t Rush It!
  - Build vocabulary slowly to take pressure off
- Spikes
  - These are your Lego Blocks!
Teaching What and Why

- Common off aroma / flavor checks
  - Diacetyl Rests
- Aroma and tastings through-out the brewing processes
  - From Wort to Package
- Technical Feedback
  - True to Brand / Consistency
BUILDING BLOCKS

- No Pressure Panels
- Build up your own Attribute Library
  - Everyone Participates / Good Motivator
- Lower threshold levels
- Different Styles
- Oxidation Stages
- Brand Recognition
Flavor Wheel
SETTING UP FOR SUCCESS
Teach the Basics and Share as Much as Possible

APPEARANCE (Clarity and Chill Haze)
AROMA
SERVE AT AN APPROPRIATE DRINKING TEMPERATURE
TASTE (Don’t DRINK!)
  Scoring System
AFTERTASTE
  We don’t spit beer!
BLIND TASTING (Fair and Good Practice)
LIMIT THE NUMBER OF BEERS TO AVOID TASTEBUD BURNOUT
PALATE CLEANSERS (Plain Crackers and Water)
LEARN / TEACH TO NOT FINISH THE WHOLE SAMPLE
MOTIVATION

- Change things up / variety
  - Different types of Panels
    - Aroma Vials, Spikes, Triangle Tests, Preference
  - Everyone learns differently
- Positive Rewards
- Feedback and Guidance
- SERIOUS BUSINESS BUT FUN!
TRAINING, VALIDATION AND FEEDBACK OF A PRODUCTION/MARKET RELEASE PANEL

Cathy Haddock
Sensory Specialist Quality Assurance Dept. Sierra Nevada Brewing Co.
CBC Annual Meeting, 2011
Why is it important to have a trained and validated panel?

□ A trained sensory panel is a valuable instrument; each taster being a unique tool in the toolbox.
  • Can not rely on just 1 opinion. Everyone has their own sensitivities.

□ Example: Brew master who is blind to diacetyl is the sole taster for release of product to market. Not good!
What is a Production Release Panel?

- Production Release Panel - a trained panel that evaluates product to be release to market.
- Panel can use various quality control tests such as a go-no go, in/out yes/no, pass/fail, quality ratings, etc. format.
Training Process-
Production Release Panel

- If you are on the Production Release Panel you must be trained and validated on off flavor recognition and brand attribute!!
What to train with??

Train using spiking compounds.

- **Flavor Activ**…quick, easy, good shelf life, but costly, cost varies per compound.

- **Seibel Training Kit**….quick, easy, shorter shelf life (2 months-refrigerated), 25 vials for $180.

- **Sigma Aldrich Flavor and Fragrances Kit**-some dilution prep work. 22 vials for $473. No DMS or Acetaldehyde. Good shelf life.
Next Steps

- Identify what key flavors and off flavors are important and train on those compounds.
- Recommend spiking and training with a flagship brand, as well as any other brands if time and expense is available.

A spiking in one brand, can come across different in another brand.
### Types of Training/Validation Methods:

- **Off Flavor Recognition Testing** - present panelist with spiked beer samples for evaluation and identification. *Recommend 6 samples in a session.*

- **Brand Attribute** - training with pantry reference standards, one-on-one and group exercises.

- **Sensitivity Threshold Testing** - provides training on how compounds are perceived at various concentrations as well as gain insight on panelist sensitivities.
Tasters report from test session-taste panelists are known by a 4 digit code.

Panel average = 85.0%.
<table>
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<tr>
<th>Date</th>
<th>Description</th>
<th>2010 avg</th>
<th>2009 avg</th>
<th>2009/2010 avg</th>
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<td>76.9%</td>
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<td>80.4%</td>
<td>#DIV/0!</td>
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<td>76.5%</td>
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<tr>
<td>12/3/2010</td>
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<td>97.2%</td>
<td>97.5%</td>
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<tr>
<td>12/17/2010</td>
<td>dms</td>
<td>75.4%</td>
<td>78.1%</td>
<td>59.2%</td>
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<td>earthy</td>
<td>95.6%</td>
<td>81.7%</td>
<td>80.4%</td>
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<td>ethyl butyrate</td>
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<td>72.6%</td>
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<td>ethyl hexanoate</td>
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<td>83.4%</td>
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<tr>
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<td>freshly cut grass</td>
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<td>62.5%</td>
<td>8.2%</td>
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<tr>
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<td>geraniol</td>
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<td>72.3%</td>
<td>74.5%</td>
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<tr>
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<td>isoamyl acetate</td>
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<td>74.3%</td>
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<td>94.1%</td>
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<td>86.9%</td>
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<td>plastic</td>
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<td>33.5%</td>
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<td>sour</td>
<td>63.9%</td>
<td>64.2%</td>
<td>46.5%</td>
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<tr>
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<td>lactic acid</td>
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<td>66.6%</td>
<td>66.6%</td>
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<tr>
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<td>65.0%</td>
<td>65.0%</td>
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<tr>
<td>50.00%</td>
<td>methional</td>
<td>92.9%</td>
<td>81.7%</td>
<td>81.7%</td>
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<tr>
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<td>58.4%</td>
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<td>easy</td>
<td>70.3%</td>
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<td>mod</td>
<td>80.0%</td>
<td>53.3%</td>
<td></td>
</tr>
<tr>
<td>25.00%</td>
<td>hard</td>
<td>80.0%</td>
<td>53.3%</td>
<td></td>
</tr>
</tbody>
</table>

**Difficulty Levels:**
- **Easy:** 75-100%
- **Mod:** 56-75%
- **Hard:** 0-55%
Charts allow visualization of taste panel recognition abilities.

The beers that are bottle conditioned at 62 deg. F, whether normal or elevated yeast pitch, measured having higher levels of diacetyl.
Brand Attribute Training

- Determine what are the key attributes in your brand and associated descriptors.
- Find Reference Standards to demonstrate those attributes.

Example: Fruit note in Sierra Nevada Pale Ale is our yeast; make yeast cake and serve side by side with the beer.

- As a Panel, discuss changes in those attributes in different ages of beer.
Threshold Testing -
ASBC Method of Ascending Limits

- 6 triangle tests
- Go from lowest to highest concentration with threshold in the middle.
- Test samples increase in concentration, usually 2-fold.
- Get Best Estimate Threshold of group; geometric mean of the highest concentration missed and next higher (adjacent) concentration.
- Get an individual and panel BET average.
- Take into account amount of compound in beer matrix.
### THRESHOLD OF ISOAMYL ACETATE

**Procedure:** ASBC Sensory Analysis - 9 (Ascending Method of Limits)

**Medium:** Miller High Life

**Dilution Factor:** 2

**Sample:** Isoamyl Acetate Aldrich Cat. # 112674 98%

**Form of Test:** Simple / Aroma Only

<table>
<thead>
<tr>
<th>Taster Order</th>
<th>Name</th>
<th>Concentration, ppm</th>
<th>Individual BET, ppm</th>
<th>Threshold Log 10</th>
<th>Description</th>
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<td></td>
<td></td>
<td>0.375 0.75 1.5 3 6 12</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>taster 1</td>
<td>N N Y Y Y Y Y Y</td>
<td>1.06</td>
<td>0.026</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>taster 2</td>
<td>Y Y Y Y Y Y Y Y</td>
<td>0.27</td>
<td>-0.576</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>taster 3</td>
<td>Y Y Y Y Y Y Y Y</td>
<td>0.27</td>
<td>-0.576</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>taster 4</td>
<td>N Y N Y Y Y Y</td>
<td>2.12</td>
<td>0.327</td>
<td>fruity, banana</td>
</tr>
<tr>
<td>5</td>
<td>taster 5</td>
<td>N N N N Y Y Y Y</td>
<td>4.24</td>
<td>0.628</td>
<td>fruity, banana</td>
</tr>
<tr>
<td>6</td>
<td>taster 6</td>
<td>N N N Y Y Y Y Y</td>
<td>1.06</td>
<td>0.026</td>
<td>banana</td>
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<tr>
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<td>1.06</td>
<td>0.026</td>
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<td>8</td>
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<td>9</td>
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<td>0.026</td>
<td>Isoamyl acetate</td>
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<tr>
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<td>Isoamyl acetate</td>
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<td>taster 19</td>
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<td>4.24</td>
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<tr>
<td>26</td>
<td>taster 26</td>
<td>Y Y Y Y Y Y Y</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Statistical Summary:**

- Group Best Estimate Threshold (BET), ppm = 1.09
- Sum Log 10 = 1.114
- Average Log 10 = 0.056

---

Data collected at 2005 ASBC workshop by Everett Boiling
Graph of Individual Tasters BET

Individual BET, ppm-Isoamyl acetate

- BET-1.09
- 0.270, 0.270, 0.270, 0.270, 0.270, 0.270, 0.530, 0.530, 0.530
- 1.061, 1.061, 1.061, 1.061, 1.061, 1.061
- 2.122, 2.122, 2.122, 2.122, 2.122
- 4.244, 4.244, 4.244

Individual BET, ppm
More than Performance Feedback, …say Thank You!!

It takes a time and commitment to be on panel. A lot of training is involved.

Say “Thank you” with a ………

- Post-sensory treat/snack
- Rewards Program-gift certificates, prizes, etc. (Frequent Tasters Reward Program)
- End of the year parties
- Positive Feedback-be a cheer leader
- Free Beer!!
SENSORY STATISTICS: TRANSFORM YOUR SUBJECTIVE TASTE PANEL INTO AN OBJECTIVE MEASUREMENT.
Beer’s job is to deliver 10 minutes of pleasure…
So, we need to:

- Understand your brand’s flavor profile: TTB (trueness to brand). Know the difference between normal process variation, process trends and/or anomalies. Consistency! Identify and classify flavors and determine their desired levels for a given brand. Then, pinpoint their origins from grain to glass/processing.

- Provide specific-technical-actionable flavor interpretations to help production correct flaws, identify trends and better control the outcome of each brew.

- Keep it simple, thorough repeatable, reproducible test method and data analysis.
What do I do with my production release data results?

- How bad is ‘too bad’? Sellable vs. non-sellable finished product.
- What is normal/natural process variation?
- What is out of specification? What warrants investigation?
- How can you avoid flavor shift over time?
- Is the product defect enough to cause the consumer to notice? Complain? Recall?!?

Need to Move away from grading. 1 out of 10 panelist (no go) ≠ 90% A. What about 3 of 20? 85% B- 3 diacetyl comments?!?!

Move away from tests that generate limiting, unactionable, un’mine’able data – scaling, ttt. Final score = 16- 76%
The perfect tool for Sensory Finished Product Release Panel Analysis:

- A p-chart (probability chart) is an attributes (ttb or not ttb) control chart that consists of points collected and plotted with the control/natural process limits from data in subgroups of varying sizes (different number of and panelists every panel).

- Think of the limits as the ‘voice’ of your process. P-charts monitors normal variations: whether your process is stable and predictable and determines whether a particular sample falls within the normal variation or falls outside and needs to be examined further. Can also monitor the effects of process improvement theories (test brew validation) or spikes (panel validation).

- P-charts can easily be created using simple excel add-ins that are pretty cheap and easy!
Production Release Ballot and Data Entry

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<th>Sample</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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</table>

- Check it out-probability charts in action....
- Looks like your normal data entry spreadsheet.
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<th>Package</th>
<th>Date of Pack</th>
<th>Production</th>
<th>Clarity Source</th>
<th>Clarity Defects</th>
<th>Aroma Source</th>
<th>Aroma Defects</th>
<th>Flavor Source</th>
<th>Flavor Defects</th>
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Normal process variation.

![p-Chart](image-url)
Out of Control data patterns- alert!
Your process is changing behavior!!

- One or more points outside of the control limits
- 7 consecutive points on the same side of centerline
- 7 consecutive intervals entirely increasing or decreasing
- 2 out of 3 consecutive points in the same zone A or beyond
- 14 consecutive points alternating up and down
- 4 out of 5 consecutive points in the same zone B or beyond
- 14 consecutive points in either zone C
Is your panel ‘plugged in’? Validation via spiked sample.

- aroma
- taste/aftertaste
- mouthfeel/body
- overall flavor
clarity trend
Sensory Decision Tree
General
Last Revision: September 10, 2010

If Product is OOC in the Sensory p-chart:
- Perform risk assessment
  - Significant risk?
    - YES: Send ALARM email to Sensory Team with p-chart results
    - YES – re-taste: Re-test on panel w/ 1-2 controls
    - Put product on HOLD?
      - Bottle?
        - YES: Request new keg from Dominion
        - NO: Passed re-test?
          - YES: BREWMASTER Decision
          - NO: BREWMASTER Decision
      - Keg?
        - YES: BREWMASTER Decision
        - NO: BREWMASTER Decision
  - NO: Send FYI email to Sensory Team with p-chart results
    - RED FLAG / data violation?
      - YES: BREWMASTER Decision
      - NO: Send ALARM email to Sensory Team with p-chart results
    - YELLOW FLAG / data trend?
      - YES: BREWMASTER Decision
      - NO: Send FYI email to Sensory Team with p-chart results
- Investigate root cause (who?)
- Need project / change in procedure?
  - YES: Fill out test request form, Schedule test
  - NO: Schedule test
- Document: Reason for release/dump, corrective action (NWA, sensory schedule, & All Brands spreadsheet)
- BREWMASTER Decision
- BREWMASTER Decision
- Schedule for shelf-life re-test
- Release HOLD / Release product
overall flavor out of control—not true to brand.

diacetyl comments
Each ‘out of spec’ scenario needs to flow like this.

... Closed Loop Corrective Action Plan!

- Identify Problem/Attribute (diacetyl comments and red OOC in aroma and overall)
- Assignable Cause (slow fermentation, t-down too early)
- Corrective Action (flag tank, measure diacetyl before t-down)
- Hold the gains (change SOGs, train on new procedure)
Taste Panel vs. Sensory Program

1. ID process, method, measurement owners
2. Initial Measurement Validation (MSA)
3. Implement and maintain applicable SOG’s
4. Training Protocol & Records
5. Establish appropriate charts (Pcharts)
6. On going Validation Method
7. Calibration
8. OOC/OOS Action Plan Development/Decision Trees
10. Document First Pass Analysis in control chart
11. Cleaning the data set- Brewmaster Ready
12. Trends/Pareto Analysis and Recommendations
13. Present in Quality Meeting
14. Transition to Project/Investigation ideation
P CHART ADD-IN WEBSITES

- http://www.isixsigma.com/library/content/n070223a.asp
- www.XLSTAT.com

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