

ASBC Annual Meeting

June 4–7 ■ Fort Myers, Florida

See what SCIENCE can brew for you

Starting a research program

Luke Chadwick

Senior Scientist, Bell's Brewery Inc.

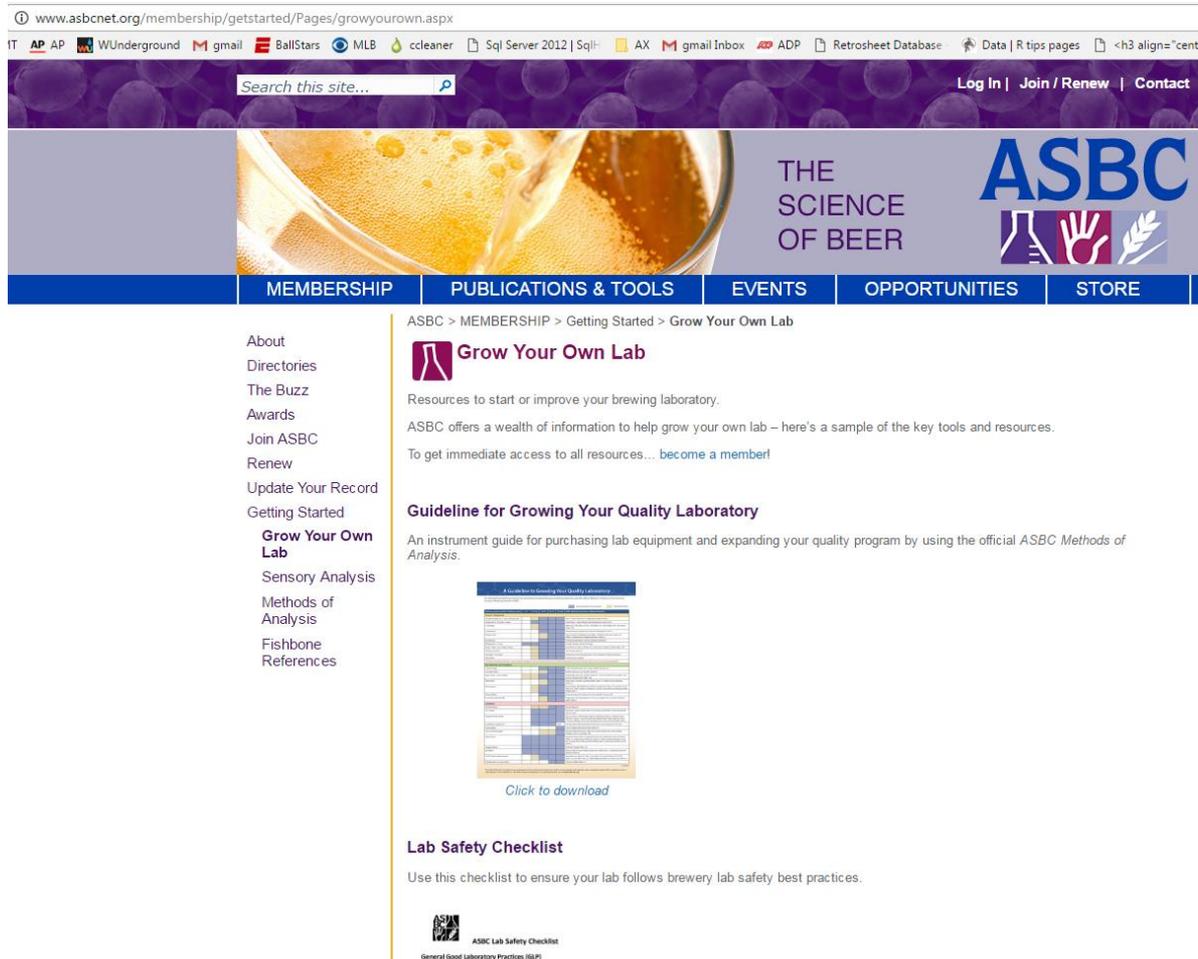


Inspired Brewing®

Research: the generation of new knowledge relating to better control of beer quality.

Lab equipment \subseteq Analytical tools

The most important research tools relate to the high-level structure and purpose of the work. For guidance on laboratory equipment purchases, start with the ASBC 'grow your own lab' documentation



www.asbcnet.org/membership/getstarted/Pages/growyourown.aspx

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MEMBERSHIP PUBLICATIONS & TOOLS EVENTS OPPORTUNITIES STORE

ASBC > MEMBERSHIP > Getting Started > Grow Your Own Lab

Grow Your Own Lab

Resources to start or improve your brewing laboratory.

ASBC offers a wealth of information to help grow your own lab – here's a sample of the key tools and resources.

To get immediate access to all resources... [become a member!](#)

Guideline for Growing Your Quality Laboratory

An instrument guide for purchasing lab equipment and expanding your quality program by using the official ASBC *Methods of Analysis*.

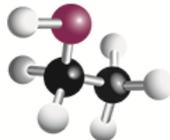


[Click to download](#)

Lab Safety Checklist

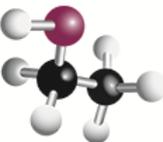
Use this checklist to ensure your lab follows brewery lab safety best practices.

ASBC Lab Safety Checklist
General Good Laboratory Practices (GLP)



Why do research and what can it help do for the process or quality?

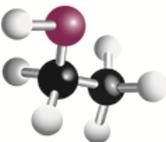
- Save money
- Save time
- Save materials
- Increase knowledge
- Improve workflow
- Understand new flavors
- Make more consistent beers



Basic steps

Following these steps will lead you to all the tools you need

1. Define the problem
2. Literature review
3. Define the endpoints and establish a way to measure them
4. Factor exploration
5. Design of Experiments
6. Carry out experiments
7. Process and Review the data
8. Curate the data



1. Define the Problem

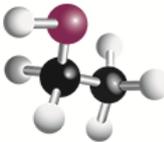
A well-defined problem often contains its own solution within it, and that solution is usually quite obvious and straightforward. By defining problems properly, you make them easier to solve, which means saving time, money and resources.

-Michael Cooper

Defining Problems: The Most Important Business Skill You've Never Been Taught

<https://www.entrepreneur.com/article/237668>

Sep 26, 2014

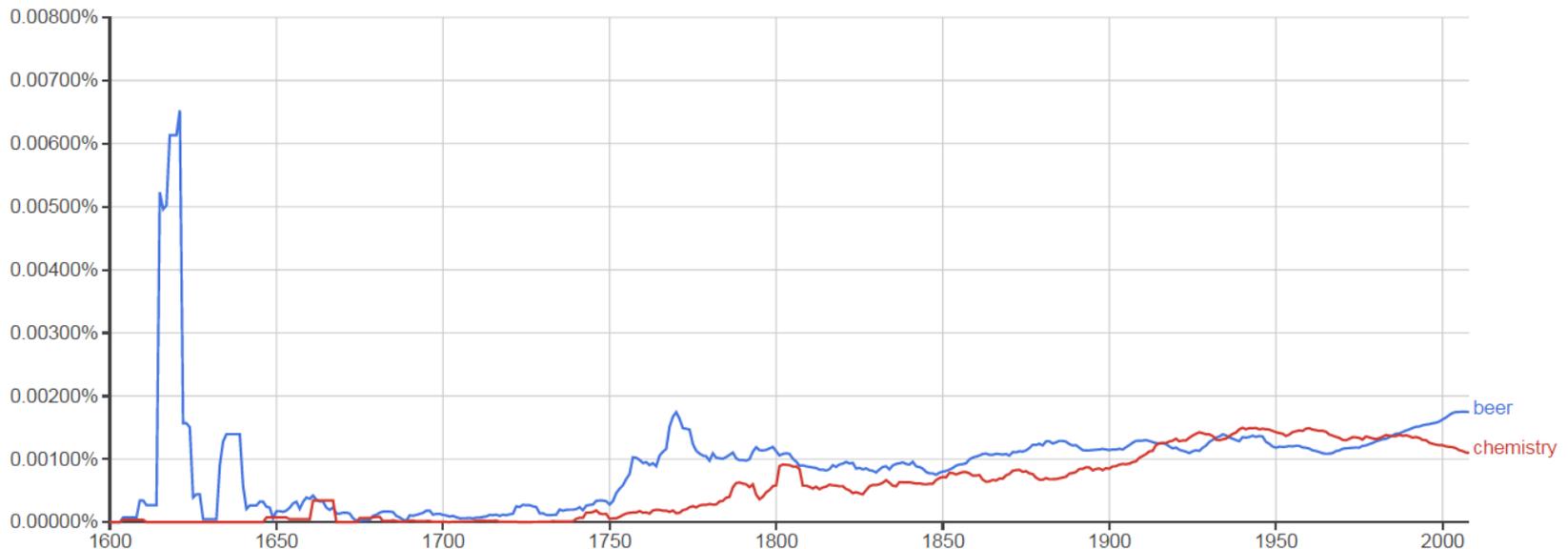


2. Literature review

- Don't rush to measure until you have solid foundation of the relevant literature.

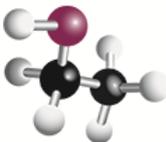
Google Books Ngram Viewer

Graph these comma-separated phrases: beer,chemistry case-insensitive
between 1600 and 2008 from the corpus English with smoothing of 3 [Search lots of books](#)



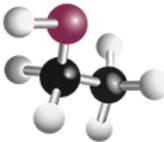
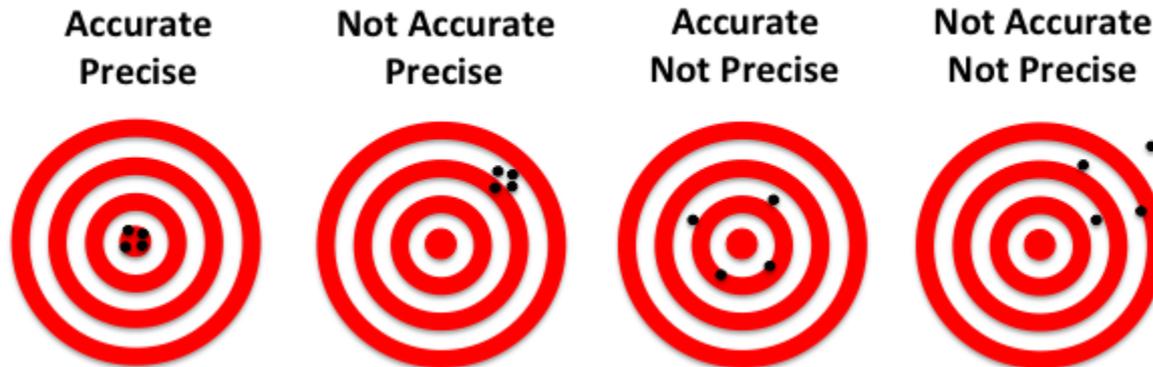
"A month in the laboratory can often save an hour in the library."
- Frank Westheimer

2017 ASBC Meeting



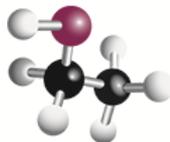
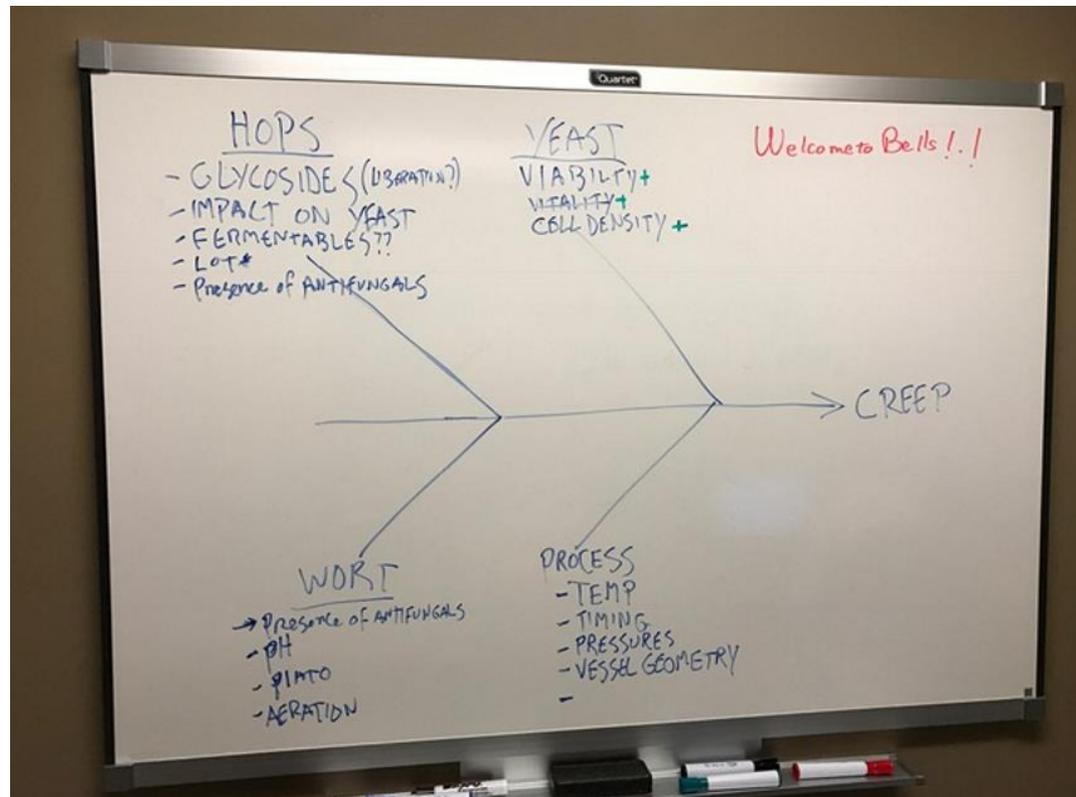
3. Define endpoints and measurement system

- Sensory? Analytical? Micro?
- Keep it numerical
- Establish measurement error
 - Carefully chosen standards and control samples
 - Match the matrix!
 - Gage Repeatability and Reproducibility (GageR&R)



4. Factor exploration

- With the biggest team of stakeholders you can pull together, make a list of all potential variables that could impact the endpoint in question (positively or negatively)



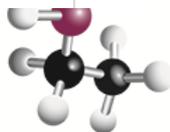
5. “Design of Experiments”

Factors → endpoints

- Decide which factors to..
 - Vary as part of the experiment
 - Hold constant
 - [only] document
- Establish in advance:
 - Home for the data
 - criteria for action/success
 - (Reaction plans)

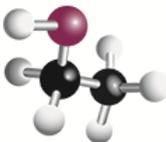
The screenshot displays the Minitab interface for creating a factorial design. Two dialog boxes are open: 'Create Factorial Design' and 'Create Factorial Design - Factors'. The 'Create Factorial Design' dialog shows '2-level factorial (default generators)' selected for 3 factors. The 'Create Factorial Design - Factors' dialog lists three factors: A (wort pressur), B (O2 flow), and C (pitchtime), each with a low and high value. Below the dialog boxes, a worksheet titled 'Worksheet 2 ***' contains the following data:

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
	StdOrder	RunOrder	CenterPt	Blocks	wort pressure	O2 flow	pitchtime				
1	6	1	1	1	18	0.88	1				
2	4	2	1	1	18	1.12	0				
3	3	3	1	1	14	1.12	0				
4	8	4	1	1	18	1.12	1				
5	1	5	1	1	14	0.88	0				
6	7	6	1	1	14	1.12	1				
7	5	7	1	1	14	0.88	1				
8	2	8	1	1	18	0.88	0				
9											



6. Carry out experiments

- Incorporate replicates and 'knowns'
- Safety always!
- Review all possible hazards
- Safety Data Sheets (SDS) onsite
- Proper PPE
- No tasting anything that isn't food-grade!
 - Dedicated collection vessels and glassware for sensory work!



7. Process and Review the data

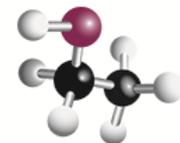
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 20170414a_1min baseline.raw
 20170414a_ms014salt_etoh__blank_01.raw
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 20170414a_ms014salt_qc__asc_18.raw
 20170414a_ms014salt_etoh__blank_1_2ndinj.raw

file	sample	myrcene	2mbib	linalool
OARS_ran_w5_t34_v4	OARS	22218752		5265920
2HE1_ran_w11_t40_v10	2HE1	274268160	81203200	3805184
HSLM_ran_w12_t41_v11	HSLM	181829632	27481088	3408128
QC_ran_w13_t42_v12	QC	111255552	31678464	3796992
SMIT_ran_w15_t44_v14	SMIT	183926784	21799936	3910144
SMIT_ran_w17_t46_v16	SMIT	186548224	20895744	
HSLM_ran_w20_t49_v19	HSLM	187203584	29944832	
2HE1_ran_w21_t50_v20	2HE1	304103424	93782016	
OARS_ran_w23_t52_v22	OARS	27752448		
QC_ran_w26_t55_v25	QC	115159040	32777216	477264
QC_ran_w30_t59_v29	QC	113684480	36069376	825600
SMIT_ran_w32_t61_v31	SMIT	175996928	22681600	973248
HSLM_ran_w33_t62_v32	HSLM	197427200	31766528	526336
OARS_ran_w34_t63_v33	OARS	24755200		898752
2HE1_ran_w36_t65_v35	2HE1	279920640	94097408	2091648

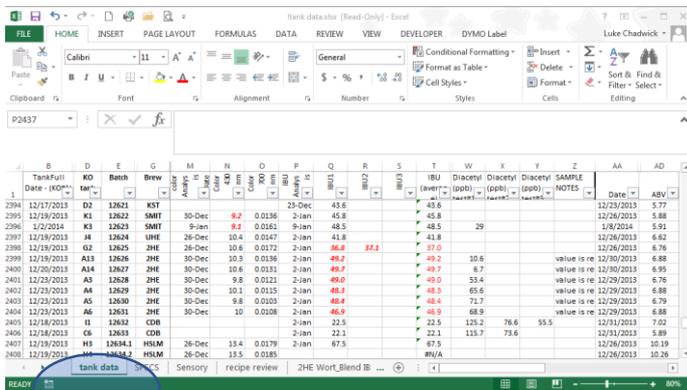
sample	myrcene		2-methylbutyl isobutyrate		linalool	
	mean	CV	mean	CV	mean	CV
2HE3	3,120	4.3%	290	2.3%	157	7.8%
HSLM	2,084	1.2%	49	6.9%	39	0.9%
OARS	143	87.8%	8	0.7%	39	1.7%
SMIT	1,956	0.3%	39	3.1%	44	18.9%
QC__	1,240	1.8%	54	4.4%	40	1.0%

Pivot tables, conditional formatting and heatmaps are awesome

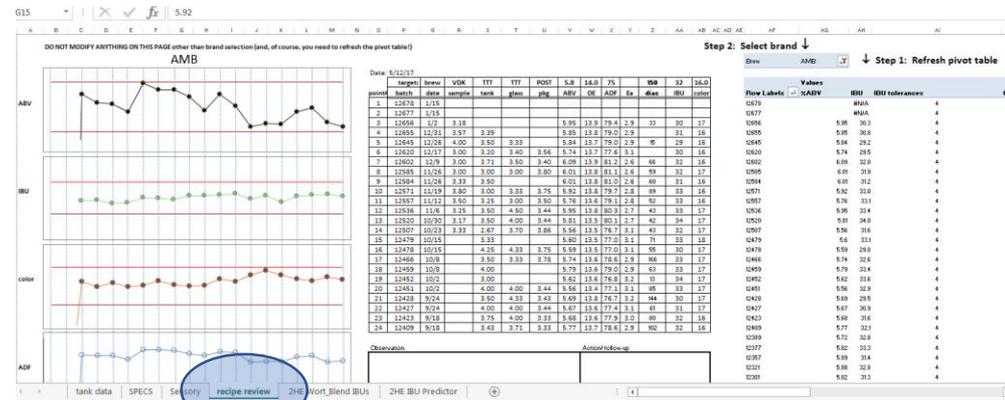
$$CV = \text{Coefficient of Variation} = RSD = \text{relative standard deviation} = \frac{\text{standard deviation}}{\text{average}} \times 100\%$$



7b. Process and Review the data

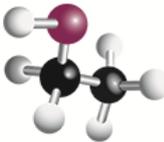


Data entry sheet



Data summary sheet

[in advance]: Think through the relationship between data entry and data summaries



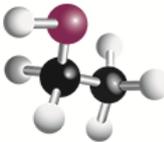
8. Curate the data

- It doesn't end with the creation of a table or a graph
 - Research results must be...
 - Translated
 - Communicated
 - Documented
- To non-scientists

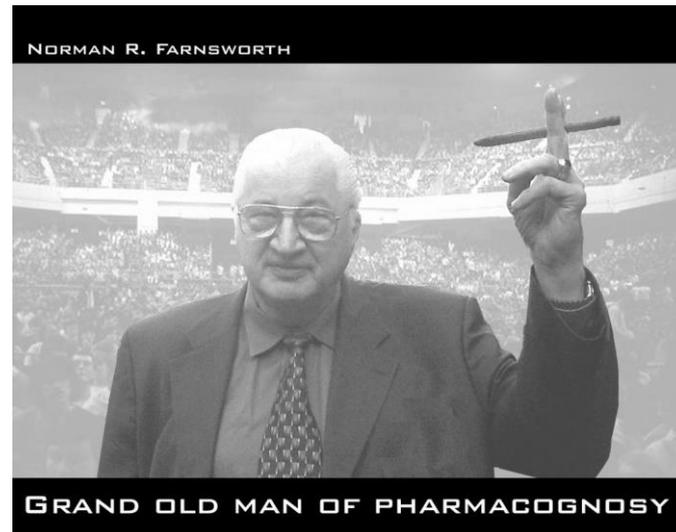
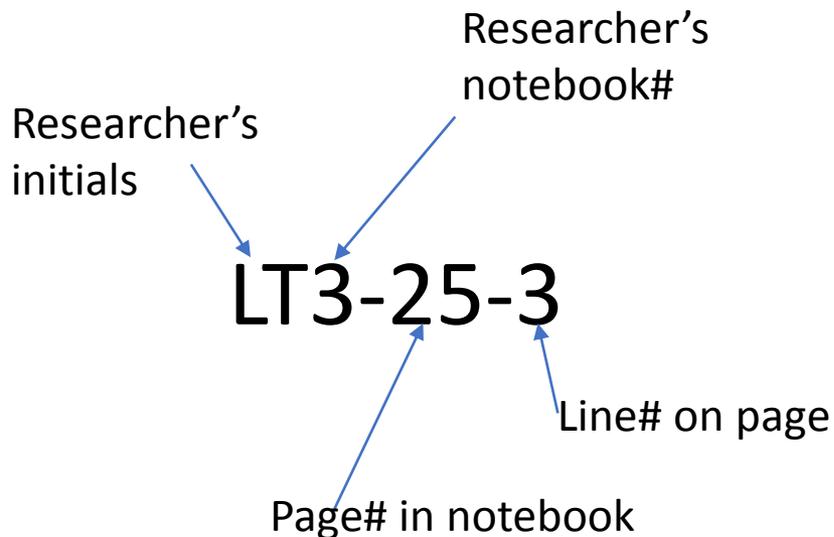
A codified approach to research will lead you either to the next set of experiments, the next research project, or the satisfaction that the problem is solved!

Well-curated data from well-designed experiments will be useful to posterity. Even if the results are 'negative'.

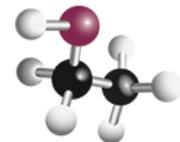
Note: curate \approx summarize+archive \neq censor or massage



Example: Dr. Norman R. Farnsworth's sample coding system



If we need more info about this sample, we go to the notebook LT3, flip to page25, and down to line#3 and the info we need.



Summary

- Don't use research to find problems
- DO use research to attack them!

