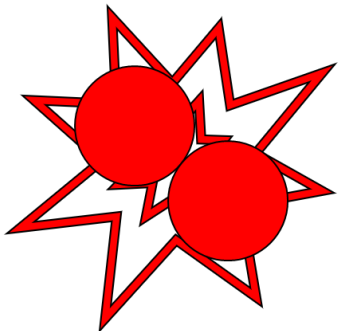
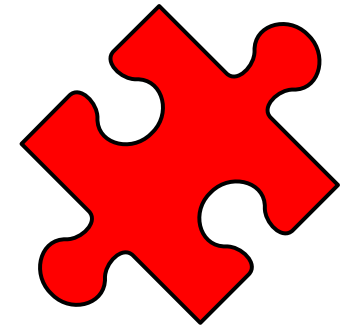


The Collision Theory of Hypothesis & Experiment Generation

BERDC Special Topics Talk 16



DaCCoTA

DAKOTA COMMUNITY COLLABORATIVE
ON TRANSLATIONAL ACTIVITY

Dr. Mark Williamson

Biostatistics, Epidemiology,
and Research Design Core

Opening

Goal: Boost your ability to generate hypotheses and experiment ideas

- ✦ Become a Well-read Monster 
- ✦ Bridge Different Disciplines Together 
- ✦ Creatively Select and Prune Proposals 
- ✦ Learn from the Best 

Introduction

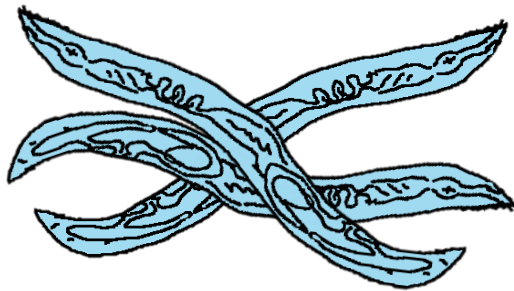
Theory: *“Colliding ideas together from many sources is a helpful tool for hypothesis and experimental generation”*

- ✦ Topics like scientific literacy, the scientific method, and statistical analysis, are staples of scientific education
- ✦ However, little attention is given to the process of hypothesis or experiment generation
- ✦ The goal of this presentation is to remedy that shortfall
- ✦ Fast and loose territory, so take everything with grain of salt
- ✦ Go for it!

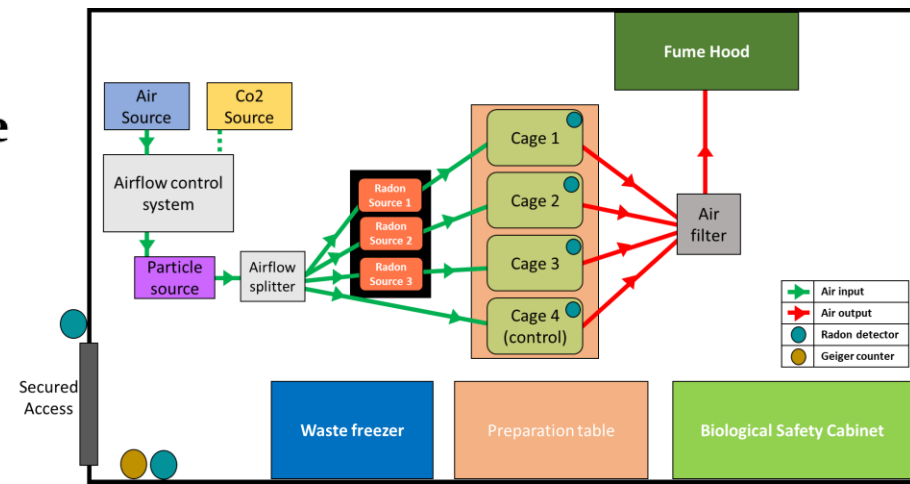
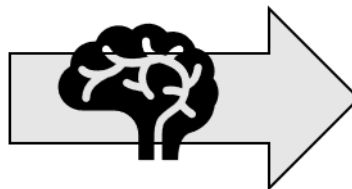


Well Read

- ✦ *You can't aim at something, let alone hit it, if you don't know the target even exists*
- ✦ Aim to read important scientific papers far and wide
- ✦ Follow interesting leads, even if they don't match needs right away (surprising what may come of it)



Model of
Neurodegenerative
Disease



Well Read

Some Ideas:

- ✦ List of important journals
 - ✦ Depends on field
 - ✦ Curate by hand
 - ✦ Can also use Scimago
- ✦ Science aggregation sites
 - ✦ Science Daily
 - ✦ EurekAlert!
 - ✦ Advanced Sciene News

SJR Scimago Journal & Country Rank

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Only Open Access Journals Only ScELO Journals Only WoS Journals Display journals with at least 0 Citable Docs (Years) Apply

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Title	Type	SJR	H Index	Total Docs (2021)	Total Docs (Years)	Total Refs (2021)	Total Cites (Years)	Citable Docs (Years)	Cites / Doc. (Years)	Ref. / Doc. (2021)
1 Forum of Mathematics, Pi	journal	3.389	18	8	22	338	56	22	2.38	42.25
2 Journal of Statistical Software	journal	2.852	155	60	195	3138	1457	195	6.27	52.30
3 Scientific data	journal	2.468	90	295	1088	14657	8945	418	7.70	49.68
4 Journal of Machine Learning Research	journal	2.393	221	290	605	16703	3566	605	5.41	57.60
5 Probability Surveys	journal	2.010	41	7	19	467	50	19	3.08	66.71
6 R Journal	journal	1.892	46	92	188	2521	1003	182	1.68	28.49

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Well Read

Some Ideas:

- ✦ List of important journals
 - ✦ Depends on field
 - ✦ Curate by hand
 - ✦ Can also use Scimago
- ✦ Science aggregation sites
 - ✦ Science Daily
 - ✦ EurekAlert!
 - ✦ Advanced Science News
- ✦ **Journal-of-the-Day**
 - ✦ Python code [1]

```
Python 3.8.1 Shell
File Edit Shell Debug Options Window Help
Python 3.8.1 (tags/v3.8.1:1b293b6, Dec 18 2019, 22:39:24) [MSC v.1916 32 bit (Intel)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:\Users\Mark.Williamson.2\Desktop\Williamson Data\Python\2023_code\Journal_of_the_day.py
>>> random_journal()
True
>>>
```

RESEARCH ARTICLE | BIOPHYSICS AND COMPUTATIONAL BIOLOGY

SOBA: Development and testing of a soluble oligomer binding assay for detection of amyloidogenic toxic oligomers

Dylan Shea, Elizabeth Colasurdo, Alec Smith, and Valerie Daggett

Edited by Claudio Soto, The University of Texas Health Science Center at Houston, Houston, TX; received August 12, 2022; accepted October 17, 2022 by Editorial Board Member Angela M. Gronenborn

December 9, 2022 | 119 (50) e2213157119 | <https://doi.org/10.1073/pnas.2213157119>

1,608

Significance

Early detection and disease-modifying treatment of amyloid disease. A first step in that process is early diagnosis, which is estimated to begin 10 years before symptoms. The earlier discovery of α -sheet structures associated with amyloidogenesis led to a potential therapeutic target. Here we show that a de novo

THE ASTROPHYSICAL JOURNAL LETTERS

OPEN ACCESS

Late-time H/He-poor Circumstellar Interaction in the Type Ic Supernova SN 2021ocs: An Exposed Oxygen–Magnesium Layer and Extreme Stripping of the Progenitor*

H. Kuncarayakti^{1,2}, K. Maeda³, L. Dessart⁴, T. Nagao¹, M. Fulton⁵, C. P. Gutiérrez^{1,2}, M. E. Huber⁶, D. R. Young⁵, R. Kotak¹, S. Mattila^{1,7} + Show full author list

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[The Astrophysical Journal Letters](#) Volume 941, Number 2

Citation H. Kuncarayakti et al 2022 ApJL 941 L32
DOI 10.3847/2041-8213/aca672

Article PDF Article ePub

Research articles

Irrigated urban trees exhibit greater functional trait plasticity compared to natural stands

Peter C. Ibsen, Louis S. Santiago, Sheri A. Shiflett, Mark Chandler and G. Darrel Jenerette

Published: 04 January 2023 | <https://doi.org/10.1098/rsbl.2022.0448>

Abstract

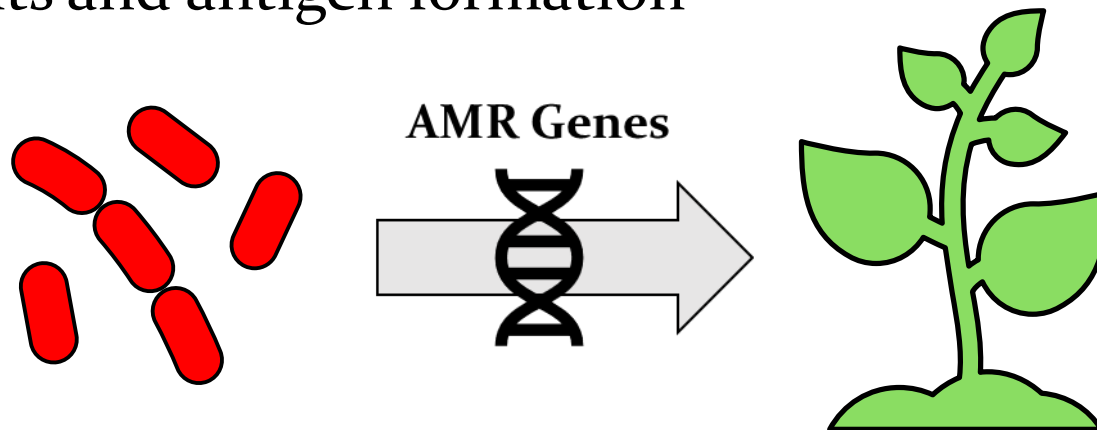
1. Introduction
2. Observations and Data Reduction
3. Results and Discussion
4. Summary

Footnotes

References

Bringing Together

- ✦ *An intractable problem in one field may be a solved afterthought in another*
- ✦ Think about how to combine different fields of study or research topic
- ✦ Different types of experts have different ways of approaching problems
- ✦ Examples of surprising synergies:
 - ✦ Henry Ford and meat packing plants
 - ✦ Origami and protein folding [2]
 - ✦ Geese flights and antigen formation



Bringing Together

Some Ideas:

- ✦ Pick two ideas and browse review articles until you find a link between the two
- ✦ Pick two jobs from different fields and look at some job postings; find a link
- ✦ **Scientific Subfield Collider**
 - ✦ Python code [3]

```
>>> collider()
How many collisions do you want?:
10
Ethics + Molecular neuroscience

Conservation medicine + Mathematics

Political economy + Functional programming

Calculus + Metaphysics

Planetary formation + Epidemiology

Category theory + Economic history

Theoretical Biology + Automated theorem proving

Number theory + Probability

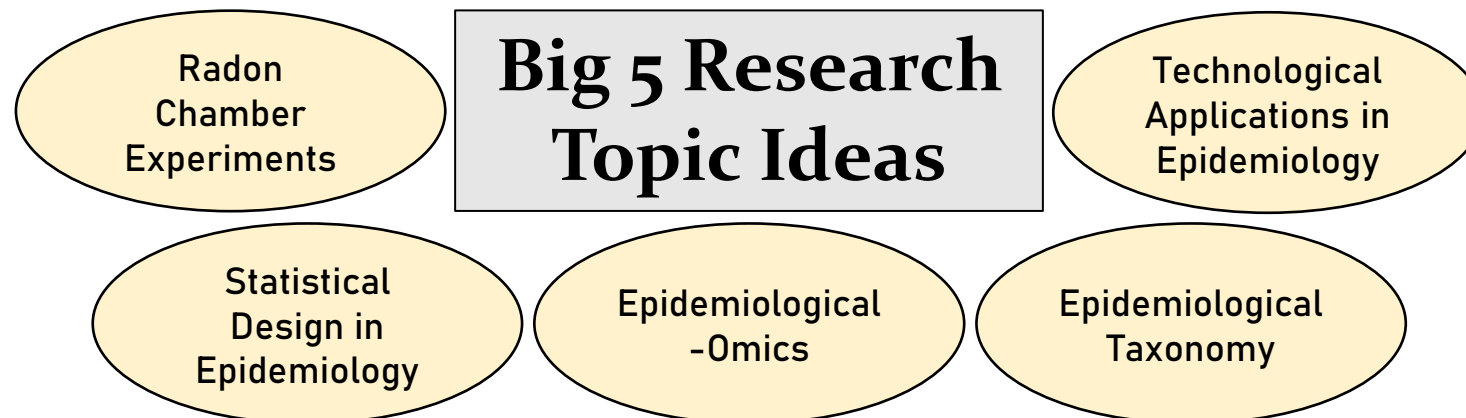
Petrochemistry + Management (outline)

Logic + Algebraic (symbolic) computation

>>> |
```


Proposal Selection

- ✦ *Generate lots of ideas and let the best ones live*
- ✦ Good hypotheses or experiment ideas don't come out of nowhere; they often require lots of subpar ideas along the way
- ✦ Brainstorming gets around your internal critic
- ✦ Research shows persistence in creativity results in better ideas the further you go [4]



Proposal Selection

Some Ideas:

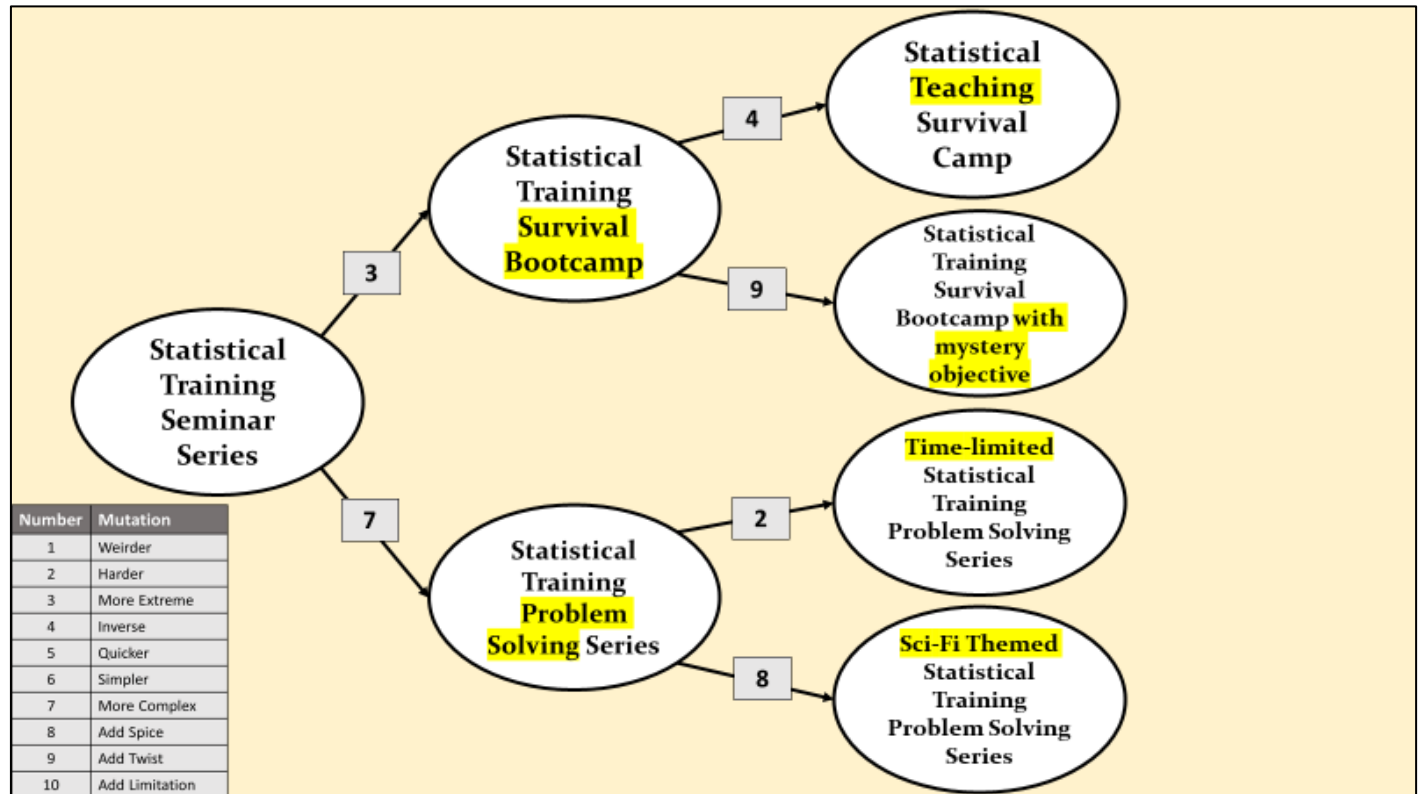
- ✦ Standard Brainstorming session
 - ✦ Mind mapping
 - ✦ Freewriting
 - ✦ Bullet points
 - ✦ Etc. [5, 6]

Proposal Selection

Some Ideas:

- ✦ Standard Brainstorming session
 - ✦ Mind mapping
 - ✦ Freewriting
 - ✦ Bullet points
 - ✦ Etc. [5, 6]

- ✦ **Idea Mutation**
 - ✦ More examples [7]



Number	Mutation
1	Weirder
2	Harder
3	More Extreme
4	Inverse
5	Quicker
6	Simpler
7	More Complex
8	Add Spice
9	Add Twist
10	Add Limitation

Proposal Selection

Some Ideas:

✦ Standard Brainstorming session

✦ Mind mapping

✦ Freewriting

✦ Bullet points

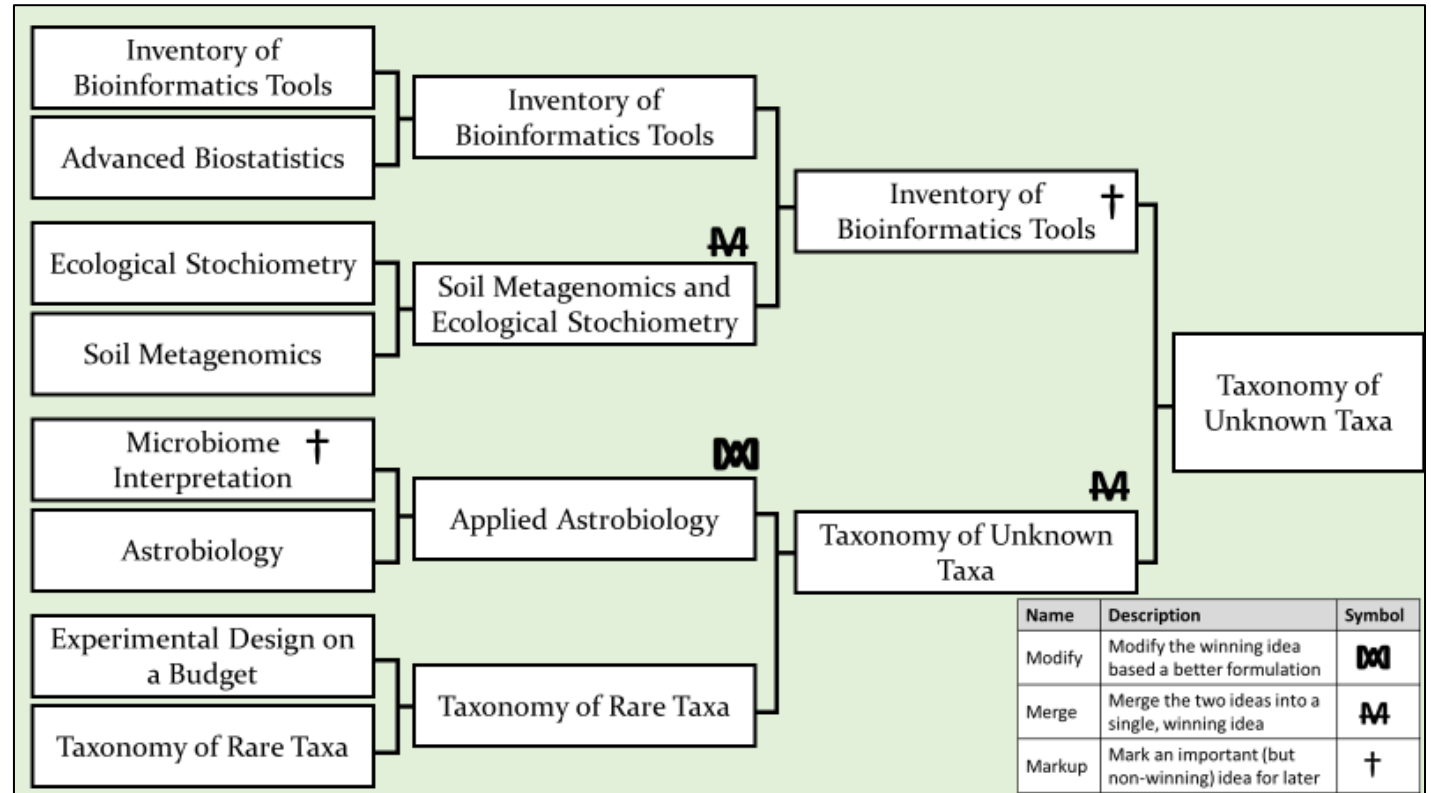
✦ Etc. [5, 6]

✦ **Idea Mutation**

✦ More examples [7]

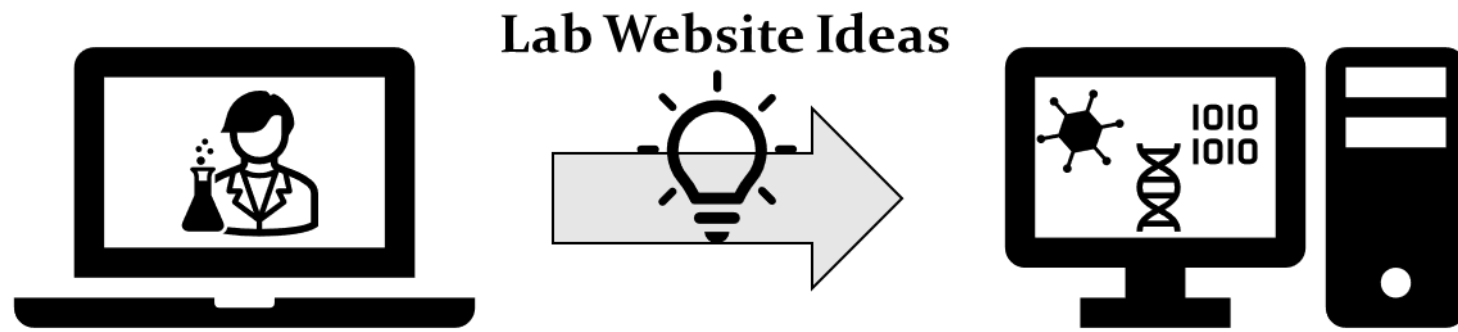
✦ **Idea Bracket**

✦ More examples [8]



Learning from Best



- ✦ *Stand on the shoulders of giants with eyes wide open*
- ✦ Seek out mentors (physical/virtual, contemporary/historical) that exemplify hypothesis generation
- ✦ Read their work, check their results, even reach out to ask questions and thank them
- ✦ Wisdom early is wisdom indeed...



Learning from Best

Some Ideas:

- ✦ Nobel Prize winners
- ✦ High impact journal authors
- ✦ Web of Science [9]

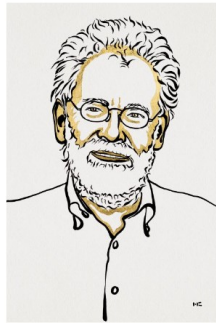
FULL NAME	CATEGORY	PRIMARY AFFILIATION	SECONDARY AFFILIATIONS	
DA Andersson, Dan I.	Microbiology	Uppsala University	-	View Profile
FB Bäckhed, Fredrik	Microbiology	University of Gothenburg	University of Copenhagen,...	View Profile
 Bäumler, Andreas J.	Microbiology	University of California Davis	-	View Profile
 Baldrian, Petr	Microbiology	Czech Academy of Sciences	-	View Profile
BF Banfield, Jillian F.	Microbiology	University of California Ber...	-	Claim profile
RB Balic, Ralph	Microbiology	University of North Carolin...	-	View Profile
RB Barrangou, Rodolphe	Microbiology	North Carolina State Unive...	-	View Profile
BJ Brouns, Stan J. J.	Microbiology	Delft University of Technol...	-	Claim profile
DB Burton, Dennis R.	Microbiology	Scripps Research	Ragon Institute, United Stat...	View Profile
FB Bushman, Frederic D.	Microbiology	University of Pennsylvania	-	View Profile



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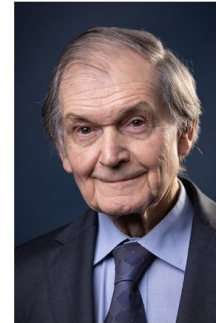
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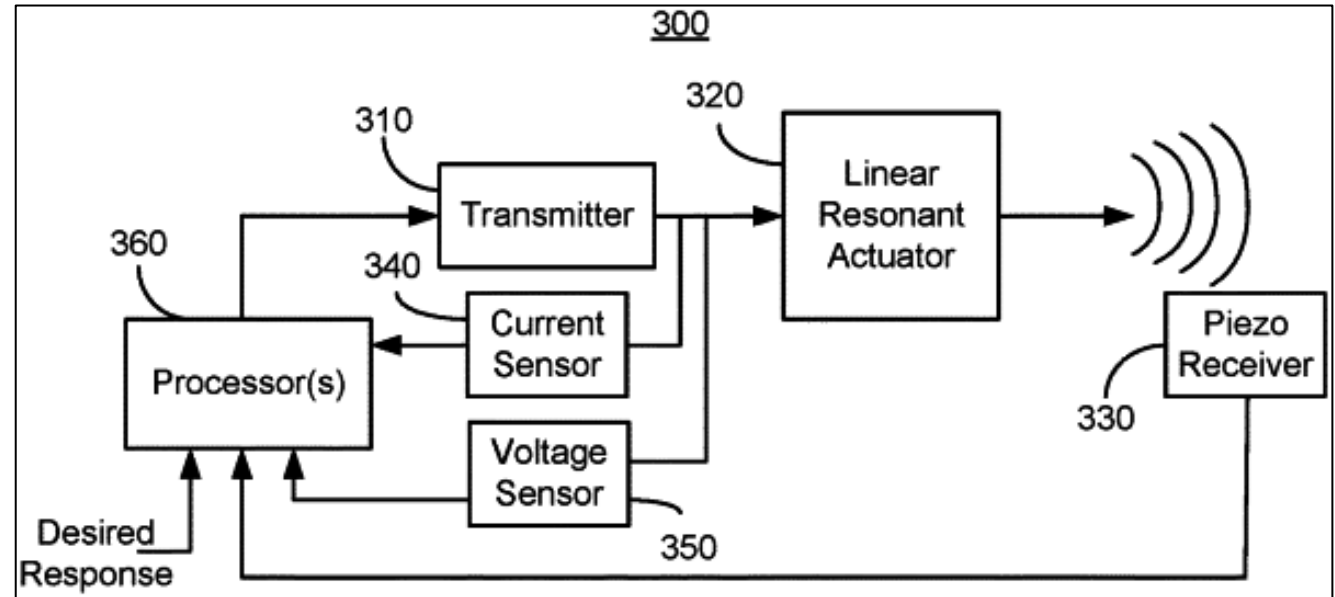
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Learning from Best

Some Ideas:

- ✦ Nobel Prize winners
- ✦ High impact journal authors
- ✦ Web of Science [9]

✦ **Patent Holders [10-12]**



Learning from Best

Some Ideas:

- ✦ Nobel Prize winners
- ✦ High impact journal authors
 - ✦ Web of Science [9]
- ✦ **Patent Holders [10-12]**
- ✦ **Local Grant Holders [13]**

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Award Number:1852459; Principal Investigator:Van Doze; Co-Principal Investigator:; Organization:University of North Dakota Main C
Amount:\$931,428.00; Relevance:65.1;

CAREER: Organization of global transcriptomes by stepwise control of Pol II activity at gene promoters
Award Number:1750379; Principal Investigator:Sergei Nechaev; Co-Principal Investigator:; Organization:University of North Dakota M
Amount:\$1,252,540.00; Relevance:63.68;

Collaborative Research: Effects of Developmental Hypoxia on Juvenile Cardiac Function
Award Number:1755282; Principal Investigator:Turk Rhen; Co-Principal Investigator:; Organization:University of North Dakota Main C
Amount:\$164,993.00; Relevance:63.57;

CAREER: Non-additive control of gene expression by long-range interactions between multiple regulatory elements
Award Number:1942471; Principal Investigator:Manu Manu; Co-Principal Investigator:; Organization:University of North Dakota Main
Amount:\$903,578.00; Relevance:63.57;

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Conclusions

Theory: *“Colliding ideas together from many sources is a helpful tool for hypothesis and experimental generation”*

- ✦ Read your way to a mental storehouse of successful experiments
- ✦ Attack problems from multiple angles with different disciplines
- ✦ Create lots of ideas, then let the best survive and thrive
- ✦ Learn from the best to profit from deposited wisdom

References

- [1] <https://github.com/MWilliamson1247/RandomScientificPaper>
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- [13] <https://www.nsf.gov/awardsearch/advancedSearch.jsp>

Acknowledgements



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