Fifteen Ways to Think About Research

Some Alignments and Metaphors

Charlie Van Loan
Department of Computer Science
Cornell University
Preamble

Let’s say you are thinking about a career that has a research component.

The ratio of that component to the “rest of the job” is vitally important and should prompt a certain amount of reflection before you go on the market.
“If I join the faculty at this or that college or university, then how am I expected to divide my time between research and teaching?”

“If I go work for a company or a lab, then will I be happy with my job’s quotient of research and development?”
Just how you compute these ratios will depend upon your own research experience and how you think about research in general.

So let’s ask a basic question...
What is Research?
Research connects to many related endeavors. How does it align with

- Teaching?
- Development Work?
- Coursework?
- Writing?
- the Creative Process?
- Undergraduate study?
- the University mission?
It’s also a complicated notion, so let’s try a few metaphors on for size. In what ways is research like

- a Maze?
- a Game?
- a Roller Coaster?
- a Pyramid?
- an Empire?
- a River?
- the Wild West?
- a Journey?
Premises

In a research environment, just being smart is not enough.

Success is a product of intellectual ability and effective social skills.

While not necessarily teachable, these skills should at least be openly discussed.
Now on with the talk...

The Alignments...
Teaching and Research
Teaching and research complement each other:

- Expository skills are refined by teaching and this multiplies one’s effectiveness as a researcher.

- Research with a passion inspires teaching with a passion. There isn’t enough teaching with a passion.
Development Work and Research
A given project usually involves a mix of research and development.

“Working out the details” of an analysis or implementation or an experiment may sound like low-level non-research, but with the right frame of mind it can prompt high-level creativity.
Coursework and Research
It is a mistake to regard the “front end” of a PhD program as sequential:

Take courses → Find a thesis topic

These activities blend together. Early coursework can coincide with the act of finding a thesis topic if the student exercises grad-level curiosity and the instructors communicate a researcher’s perspective.
Writing and Research
Likewise, it is a mistake to regard the “back end” of a PhD program as sequential:

Do the research $\rightarrow$ Write it up

These activities should blur together.
Writing, like teaching, is a great clarifier. Committing to paper that which is fuzzy in your mind focuses attention on detail.

Organizing paragraphs into sections and sections into chapters forces you to identify hierarchies of ideas.

**Writing is research.**
The Creative Process and Research
Research **does** have a serendipitous aspect...

“I am not looking for anything that I find.”

- Picasso
But your ability to spot patterns in a random event is an acquired trait...

“In the field of observation, chance favors only the prepared mind.”

- Pasteur

And that trait is manifested by rigorous academics and practical experience.
Undergraduate Study and Research
The co-authored system or paper is not the essential outcome of undergraduate research.
More important is for the student to witness (up close) something that is the opposite of standard coursework:

- A setting where the questions are usually more important than the answers.

- A setting where the faculty mentor is more of a colleague than a pontificator.
University Mission and Research
Deliver a great curriculum

Deliver the next generation of scholars
On delivering a great curriculum...

The faculty have the responsibility of bringing new research ideas into the classroom in a timely fashion.
On delivering the next generation of scholars...

The continuation of life as we know it in the research university depends upon unfettered assistant professorships, where young people are free enough to be creative.
Now the Metaphors...
Research is a Maze

False starts and dead ends.
The strategy from start to finish sounds easy-- just keep your right hand on the wall and walk. (Try it!)

However, being strong enough to keep your hand on the wall is very hard.
The only way to proceed when working on a research problem is to keep your mind on the scientific method at all times. This requires persistence and stamina.

**Test positive for these steroids!**
Research is a Game

Rules, Etiquette, and Thinking Ahead
Colleagues move in different ways.
Learn how to analyze a board situation and how to formulate a realistic research agenda.
There are rules of engagement.

Learn how to respect related work and alternative styles of research.
When you come to the table there is an appropriate dress code.

It is open and friendly.

It is called research casual!
Research is a Roller Coaster

Max's, Min's, and g-forces
Research has its ups and downs. Emotional ups and downs are bound to correlate.

Ride first with a mentor and become convinced that minimums are followed by maximums.
Acquire confidence and learn that it is possible to work through a 5g deceleration.

Just skip lunch!
Research is a Pyramid

Base, Height, and Volume
Great researchers reach great heights. From a distance they define a smooth, glistening skyline.
In contrast, the street-level view of research is gritty and rough.

But it tells you that it is just one stone on top of another.
Regardless, we are looking at a pyramid. Its **key** attribute is volume and that is proportional to **base times height**.
Research is an Empire

Course of Empire (Thomas Cole, 1834)
Research paradigms come and go.
Hot areas rise and fall.
Infrastructure expands and contracts.
Appreciating this ebb and flow creates a healthy, realistic perspective of one's own work.
Funding agencies and universities must see their way clear from landscape to civilization and beyond.

Realization of the “next big thing” requires a warm Mediterranean climate.
Research is a River

Origin and Watershed
The bog and the brook precede the river.

Before a research idea can flow with direction it must meander and join up with other research ideas.
Although all of the action is upstream, all of the impact is downstream.

A map of the catch basin connects it all.
Research is the Wild West

Horizons and Fences
On the open, interdisciplinary prairie it is impossible to tell where one field ends and the next begins. It’s big Sky country with distant horizons.
It is both wild and civilized. Barbed wire, rustlers and branding irons are part of the scene.

But so also are the “core research” homesteads that dot the plain and give it stability.
Research is a Journey

Voyage of Life (Thomas Cole, 1842)
If it can happen in life it can happen in research.
You can become independent and leave behind the safety of home.

You can reach for great things and remain youthful in outlook.
You can lose your rudder and be at the whim of the current.
And you can always disappear into the Bermuda triangle.

**Advice**: Never get into a gondola with a strange person!
Summary

To paraphrase from the introduction, how you think about research will largely be determined by your own, individual research experiences.
But how you interpret those experiences will be a function of how well you are able to step back and put everything into context.

This talk has been about that context.
References


Contact

cv@cs.cornell.edu

Thanks!