

# Becoming a Researcher

by

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Becoming an accomplished researcher requires a long maturation process involving hard work and dedication. By performing research and by observing other researchers, you will develop strategies and techniques for doing research, and you will learn about its challenges and rewards. Most importantly, you will learn that research is not a passive profession, but one that requires continual effort, driving curiosity, and periodic self-reinvention.

## **1. Be technically excellent and work hard.**

Practice technical excellence like a musician practices an instrument. As a researcher once said, “I always hoped to stumble onto a big breakthrough until I realized the odds of that happening were like waking up in the morning and finding I had been transformed into an accomplished concert pianist.” In other words, hard work is essential. When an opportunity comes by, your preparation will allow you to recognize it and profit from it. Make your own luck.

## **2. Don't fear mistakes.**

Mistakes provide opportunities to *learn*. Understand the source of your error and fix your thinking. You'll be much better off in the long run. Learn from your mistakes (as long as they're not fatal) and move on.

## **3. Admit your mistakes.**

*Never* hesitate to admit to yourself and your collaborators when you are wrong or have made a mistake. Not doing so generates confusion, slows progress, and displays insecurity. Doing so puts closure on issues, displays maturity, and allows your thinking to advance.

#### **4. Savor successful failures.**

The difference between research and many other human activities is that each research failure is actually a success. Each idea that proves wrong or ineffective provides insights and clues for new ideas and approaches. Each failure teaches us something valuable that suggests the next step. “Negative knowledge,” that is, knowing what does NOT work and what is NOT true, is often extremely valuable. Unfortunately, books and papers tell you what works, but only rarely will tell you what doesn’t work. Counterexamples are helpful for that purpose.

#### **5. Be flexible.**

Research is contingent by nature. The next step usually depends on the one before. Each advance can open up new paths. Unexpected discoveries (is there any other kind?) suggest new ideas and directions. Be flexible and don’t fret about the long term. Be aware that you might solve a problem that is different from the one you started out to solve. Penicillin and Silly Putty were both discovered by accident. Be flexible and sensitive enough to seize opportunities since the greatest opportunities are often unanticipated. Therefore, don’t spend too much time on research planning except to collect your thoughts, stimulate your thinking, or form a vision.

#### **6. It’s the process that counts.**

While specific results are important, they are only stepping stones to future research. Therefore, even if you do not attain your stated objective, you should keep in mind the fact that the tools, techniques, and insights you obtain are of immense value by themselves. In other words, the process of research is often of as much value as the specific results you obtain. To fully appreciate this point, think about the difference between a manufactured object (such as a pencil) and the machinery needed to produce the object.

#### **7. Have a vision and defend it.**

Have a vision about what you want to see come out of your work. Think about where your work is headed. Explain and defend it to your colleagues to help you understand it better yourself. Review and update your vision periodically.

**8. Don't get discouraged and (almost) never give up.**

The research process is extremely nonlinear if not discontinuous. A year's or decade's worth of work can pay off in one day. Tools that take years to develop can yield their results for a long time afterwards. Be patient and persistent. Don't let other researchers discourage you. If they are your competitors, they may criticize your work to justify theirs. Don't believe people when they say something is impossible. Even so, the impossibility of perpetual motion does not obviate the benefits of energy-efficient machines. However, there are times when it is wise to give up. Recognizing those times can be extremely difficult.

**9. A lot of people can be wrong.**

It can be daunting and require tremendous courage when your beliefs are in the minority. However, as a researcher it is your responsibility to develop new ideas and not merely ride the latest bandwagon or trend. The most difficult hurdle is trusting in the possibility that *a few people can be right, while many people can be wrong*. That takes courage. Remember that there were times when the world was thought to be flat, Fourier series were controversial, slavery was legal, and nuclear testing was common. Unfortunately, ignorance dies hard and knowledge threatens power.

**10. Recognize when you're mentally tired and rest.**

Your brain can get tired when your body is not, and such times can be hard to recognize.

**11. Learn from the past.**

Ideas evolve over time due to the efforts of many researchers like yourself. It can be extremely enlightening to understand how prior researchers overcame obstacles that they faced. Read their biographies.

**12. What type of researcher will you be?**

There are many types of researchers. Some are artists, craftsmen, trailblazers, organizers, and polishers. The type that you are or will become is a reflection of your personality and personal philosophy. However, you may wish to consciously change your type as you mature and recognize your strengths and weaknesses.

**13. View research as an art.**

Think of research as an art and think of yourself, the researcher, as an artist. No matter how technical your field of endeavor is, you have the opportunity to exert your personal style on the work that you do. You choose your own problems, you see the world through your unique vision, and you develop your ideas through your individual thought process. Strive to produce research that has your intellectual fingerprint on it.

**14. Believe and enjoy.**

Believe and be confident in what you're doing, and enjoy doing it. Have faith that your ideas are valid and will work out eventually.

**15. Be a leader.**

A true researcher must by definition be a leader, carving out new paths, choosing directions, and taking risks. Being a leader is far more difficult than being a follower, no matter how good of a follower you may be.

**16. Reinvent yourself.**

When you're stuck in a rut or if times change, then consciously change what you're doing or how you're doing it. Such changes can be refreshing and stimulating.

**17. Respect intellectual property, and be generous and magnanimous.**

Cite the work of prior researchers correctly, thoroughly, and conspicuously. Always give credit generously to others for their intellectual contributions as you would expect from them. This is the golden rule of research.

## Acknowledgment

This article is extracted from

D. S. Bernstein, "A Student's Guide to Research," *IEEE Control Systems Magazine*, Vol. 19, pp. 102-108, February 1999.

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