

Experiences of a senior researcher

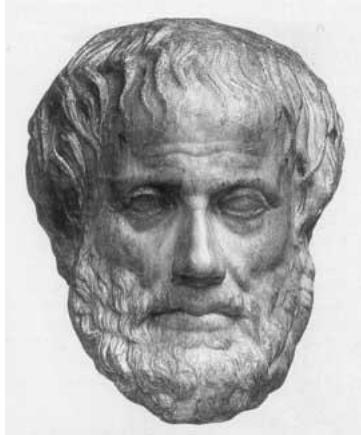
Erkki Oja

Professor

Laboratory of Computer and Information Science
Department of Computer Science and Engineering
Helsinki University of Technology

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- My talk is based on personal *experience* rather than textbooks
(many very good texts have been given in earlier talks)
- What experience:
 - Dr. Tech. in 1977, HUT
 - Research work in 6 universities, 4 countries in 3 continents
 - Advisor for 24 doctors
 - Official supervisor, opponent, pre-examiner for many
 - In 2004, 6 supervised doctors.



So, instead of him ...



Listen to him.

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(How do you succeed or fail ?)

2. WHAT IT IS

(What is scientific research ?)

3. WHERE IT COMES FROM

(What is creativity ?)

1. WHAT IT TAKES

How do you succeed or fail?

Why get a Ph.D (or D.Sc., Tkt) at all ?

- It is necessary if you are planning a career as *researcher*; guarantee of the professional status ("driver's license"); main focus of this talk
- It helps you get profound (and proven) *expertise* in a (narrow) field even if you are not a researcher
- Of my "own" 24 doctors,
 - 6 are now professors,
 - 3 are in companies,
 - 15 are senior researchers in universities or institutes .

Is it very hard to get a Ph.D ?

- It is very hard to make an *exceptionally good* Thesis, but not very hard to make an average Thesis
- With enough *motivation and willpower*, most people who have managed to get an M.Sc. can also make a Ph.D.
- Especially nowadays it is getting easier and easier due to the graduate schools offering secure financing for many years and good *supervision* (and, e.g., courses like this one).

What are the main requirements ?

- *Motivation and will*. You must want to become a doctor. Role models help a lot.
- *Material resources*: time and money. Good research groups have money or can get it for you
- A thesis *advisor* who wants to take you as apprentice.
- A suitable *problem*: not too easy, not too hard.
- Certain personal *skills and talents*, especially:
 - Ability to write fluent text in English
 - Ability to make schedules and stick to them
 - Ability to get at least one really good idea in your topic.

How can you fail to get a Ph.D. ?

- Motivation declines. There are more important things in life (industry job, raising a family, becoming a sheep farmer, ...)
- You take a part-time job in industry while "finishing" the Thesis
- Your self-criticism grows faster than your accomplishments
- It is so pleasant to be a grad student (or scary to be a Ph.D.) that you do not want to change your life
- Money runs out in your lab. You have to go
- Your thesis advisor leaves, you do not want to follow, and there is nobody to substitute for him/her
- Your problem turned out to be unsuitable.

2. WHAT IT IS

What is scientific research?



The three properties of new scientific knowledge

- A good discussion has been given by Academician Teuvo Kohonen (my own supervisor in the 70's)
- New scientific knowledge has three essential properties:

1. Originality

2. Correctness

3. Impact

- Without *all three* of these, what you have found is *not* new scientific knowledge.

1. Originality

- Knowledge should be *new*
- Not just something that your supervisor did not know, but something that *nobody in the world* knew
- With many conferences, easily accessible papers, and Web search engines (see other lectures of this course), it is easier to check the originality today than it used to be
- Once you submit your paper, competent *reviewers* should be able to check this.

2. Correctness

- Knowledge should be *correct* and *true*
- This is of course very hard! We can never prove that anything is "absolutely true", but only relative to the present state-of-the-art as defined by the international scientific community
- Competent paper reviewers should be able to check this but you cannot rely on them; the responsibility is with the authors (consider some recent frauds) .

3. Impact

- Knowledge should be *influential*
- This is even harder because the impact only comes in the *future*; so it has to be predicted
- This is where the help from senior researchers (supervisor) is absolutely necessary
- Over time, a good measure of impact is number of citations but they come too late for a Ph.D. Thesis
- Competent paper reviewers have a subjective opinion on the impact but it may be totally different from yours.



... so remember: **The Empire Strikes Back !**
There has never been a revolution without opposition.



To maximize the impact, you must work hard to impress people with your results and papers in conferences etc., and your Thesis advisor (supervisor) must help.

- Young researchers may have a too idealistic notion of how to make the impact
- Research, too, is a human activity
- *"The history of science should be X-rated"*
- But fortunately, the race for impact usually starts only after the Ph.D.

Assuming *correctness*, we could rank scientific results according to the *originality and impact* as follows:

1. Reporting obvious facts (zero research)
2. Reproducing results given by others
3. Systematic coverage of a problem field **OK**
4. New theoretical or experimental observations **OK**
5. Creation of new concepts or systems
6. Starting a new research field

Basic research vs. applied research

- Sometimes, research is divided in two parts:

1. Curiosity (basic) research:
understanding the world

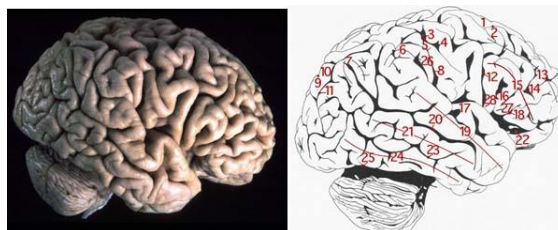
2. Useful (applied) research:
mid-term economical use

- In most engineering research, both aspects are found but the second one is predominant

- Note that both are *scientific research* as opposed to other kinds of research, *not* producing new scientific knowledge.

3. WHERE IT COMES FROM

What is creativity?



Where does the new scientific knowledge come from ?

- You have to learn the research field thoroughly by *reading* lots of books and papers – but not too many
- You have to *discuss* the problems within the research group, in seminars and conferences – with good people only
- You can *learn from* the senior researchers what is good, what is not good – if they are good scientists
- And then you just have to *think hard* !

What is creativity and is it absolutely necessary ?

- Remember that in the Ph.D. you are only *practicing and developing* scientific creativity, you are not yet a professional researcher
- Creativity can be *learned*
- It is *not* the same thing as doing well at school
- Needs *continuous thinking* of your problem (conscious and subconciuous).



Thomas Alva Edison:
"5 per cent inspiration,
95 per cent perspiration"



Louis Pasteur:
"Luck favours
a prepared mind"

THANK YOU FOR
YOUR ATTENTION !