

The Working of Scientific Enterprise

Marek J. Drużdżel

Politechnika Białostocka

Wydział Informatyki

m.druzdzel@pb.edu.pl

<http://www.wi.pb.edu.pl/~druzdzel/>

Overview

- **Motivating example (Buckminsterfullerene)**
- **Social character of science**
- **Three basic mechanisms of science**
 - **Scientific publications**
 - **Grants**
 - **Peer review**
- **Concluding remarks**

Eighteen fundamental skills of a scientist

1. **How does science work?**
2. What is research?
3. Identifying good research problems
4. Writing papers
5. Presentation in front of an audience
6. Obtaining funding
7. Reviewing/refereeing the work of others
8. Teaching
9. Guiding students, running a lab, managing projects
10. Scientific creativity
11. Information finding
12. Career planning
13. Interacting with people and networking
14. Marketing your skills: job hunt
15. Balancing your life between work and family
16. Coping with stress
17. Ethics in science
18. Appreciation for quality rather than quantity



Science in action: Buckminsterfullerene

A great example of science in action

A TV program on the discovery of Buckminsterfullerene,
available on YouTube:

<https://www.youtube.com/watch?v=pDXHAOPLMYk>

Science in action: Buckminsterfullerene

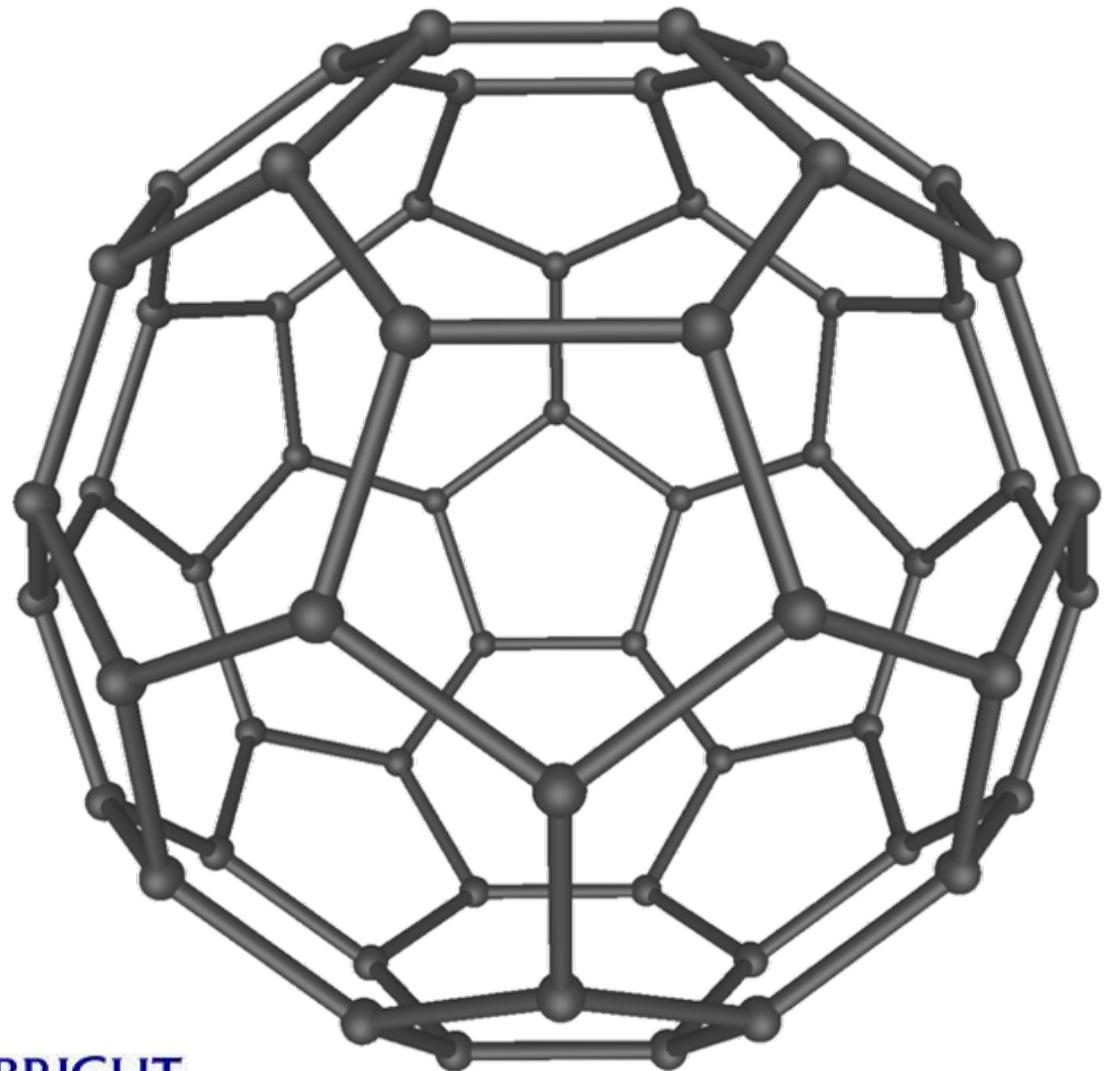
It is long (around 50 minutes) but please be patient – it is worth watching!

Please pay attention to the following:

- How did the scientists pictured in the movie get into their research area?
- How did they pick the problems to work on?
- How did they get funding for their research?
- When did they decide to publish their results and what was the potential benefit and the cost of publishing?
- Global science (World without borders)
- The importance of “networking”
- Types of scientific career paths

- Buckminsterfullerene
- Social character of science
- Scientific publications
- Grants
- Peer review
- Concluding remarks

Science in action: Buckminsterfullerenes



Science in action: Buckminsterfullerenes

Some remarks about the movie:

- How did the scientists pictured in the movie get into their research area?
 - Picking hard problems but ones that people care about
 - Unusual experiences (Kroto wanted to do architecture, knew Buckminster Fuller)
 - Enthusiasm, the importance of thinking
 - Coincidences, persistence
- Funding
 - Some places have more resources than other places (Smalley's lab in Texas, "everything is big in Texas" 😊)
 - Once you can show something, it is easier to get money (Kroto got government funding for his research in GB once he had published his Nature paper)
 - Sometimes personal funds (it may turn out to be a good investment 😊): Kroto's air ticket, Smalley's vacuum cleaner
- Publishing (being the first vs. selling your idea prematurely)
 - "Race to catch a Backyball" was the title of the original production
 - "Paper after paper was produced"
 - Huffman & Krätschmer thinking back about their old experiments and then scooping Kroto & Smalley
 - Competition that Kroto & Smalley created
 - Question: Could Smalley have gone on his own (i.e., without Kroto) after having constructed the first fullerene?

Science in action: Buckminsterfullerenes

Some remarks about the movie:

- No real boundaries for scientists: The world is small
- Networking
 - Places for sabbatical leaves (Kroto, Huffman)
 - Kroto gets a copy of a paper from a friend, who attended a workshop, later gets a paper to review
- Structure of labs (professor, post-docs, research assistants)
 - Somebody has to do the “dirty” work
- Scientists in US (quite likely majority is foreign born)
- What are the typical working places of scientists?
 - Universities
 - Industrial research labs
 - Startup companies (we did not see much of this in the movie)

Social character of science

Science has, like most human activities, a social character.

- Whether you have made a big contribution is judged by your peers (sometimes posthumously 😊).

- Whether your paper should be published, whether you should

SCOUNDREL N

M łotr; M łajdak; M łapserdak; M łobuz; M gałgan; F kanalia; F łachudra; N ścierwo; M bezecnik; M drab; M psubrat; M nędznik; M nikczemnik; F niecnota; M skurczybyk; M obwieś; F paskuda; M paskudnik; M podlec

- Whether your paper should be published, whether you should be published by your peers
- Science is not free of scoundrels, although there are more of them in other enterprises: The rewards for being a scoundrel are not that high in science.

Scientific publications

The basic mechanism of communicating results

importance/prestige

- Oral presentations (Learn how to present! How? Present, read about presenting, join *Toastmasters International*, etc.).
- Technical reports, web pages, no review.
- Books. Some are fundamental works that are meant to provoke, stir up, and disseminate a whole new view of a discipline. Sometimes summarize years of your work (published earlier). Subject to “stupid book reviews” in journals.
- Workshops, symposia, annual meetings, non peer-reviewed conferences. Very fast, some review during the acceptance process and during the presentation.
- Peer reviewed conferences. Reasonably fast and can be reputable (in our field). Subject to “stupid reviewers.”
- Journals (the concept of “obscure,” “good,” and “leading” journals). Slow, reputable; archival purpose. Subject to “stupid reviewers,” but you can argue with them.

Grants

Grants are one of the basic mechanisms in science:

- It means allocating a piece of (limited) resources to you.
- It is an indirect way of saying to you: This is a good piece of research. It is the right thing to do now.
- Gives you money to buy equipment, to travel, to fund doctoral students who will do the groundwork for you.

Funding agencies:

- National Science Foundation
- National Institute of Health
- Military agencies: DARPA, Navy, Air Force, Army
- Foundations
- Industry

Peer review

A basic mechanism of advancement in science

- Your work is judged by people working in the same area.
- Used in scientific publications and in allocating financial resources.
- Watch out conflicts of interest.
- The process is imperfect, but still good things will eventually get out to the world.
- Do it well – it is your moral responsibility.
- Treat others the way you would like to be treated.
- If you criticize somebody's work, you should be able to show a superior approach.

Concluding remarks

What is expected of you?

- People expect a few outstanding quality contributions rather than a flow of dubious quality writings.
- Your colleagues expect from you honesty, integrity, and reliability.

Concluding remarks

Your personality traits (in interaction with others)

- Whether it is good or bad, people will often let their respect for you as a person influence their respect for you as a scientist.
- Be nice to other people. Then you will not need to store all the knowledge that you will need in your head.

(Or, “you will not need to be afraid that somebody pisses in your cultures when you are not in the lab” 😊).

- Be punctual, reliable, answer your E-mail quickly. If you cannot, just send a brief message saying when you will answer.

Eighteen fundamental skills of a scientist

What next?

1. How does science work?
2. What is research?
3. **Identifying good research problems**
4. Writing papers
5. Presentation in front of an audience
6. Obtaining funding
7. Reviewing/refereeing the work of others
8. Teaching
9. Guiding students, running a lab, managing projects
10. Scientific creativity
11. Information finding
12. Career planning
13. Interacting with people and networking
14. Marketing your skills: job hunt
15. Balancing your life between work and family
16. Coping with stress
17. Ethics in science
18. Appreciation for quality rather than quantity



