

**On the evaluation of
scientific activities**
**individual physicists, collaborations,
projects and laboratories**

Herwig Schopper
CERN and University of Hamburg

**We are all being evaluated or
are evaluators**

Part of our daily business

For:

Employments, jobs

Promotions

Prizes

Funding of projects

Laboratories

A general problem appearing

**Tendency to use 'objective' and
'neutral' criteria and methods**

No personal bias

Transparency

(Full transparency = invisibility!)

**But for decisions concerning
human activities (science)
it is unavoidable and even advisable
to involve personal views**

Has science become too complicated for personal judgment?

Are people afraid to take decisions?

1. Evaluation of publications

Which **criteria** to use?

1. **Number of publications** - some information, but not sufficient.

- **No** publications - very negative sign
- Number gives no information on **their quality**

2. **the frequency of citations. Indices.**

Several bibliometric techniques have been developed and became fashionable.

Citation index, h index, *(New Pseudoscience!)*

- **Fashion** for certain topics, **chains**: once cited – again cited
- **Wrong** results are quoted sometimes more often (e.g. cold fusion)
- **Sometimes citation start only much later (Higgs)**

3. **impact factor of journals** – are papers in Science or Nature better??

'high-impact-factor syndrome' *(see A.Pawlak, 2015 and C.M.Caves 2014).*

Bruce Alberts (Chief editor of *Science*) :

“As frequently pointed out ..this ‘impact factor mania’ makes no sense..

Such metrics ..block innovation”

What to do?

The number of publications and their citations should not be used **alone** as the **only** means of evaluating scientific achievements

Publications should be read - Peer Review

but also criticised M.Baldwin (Physics Today, February 2017, 45)

Use as many criteria as possible and make your own judgement,
if possible meet the person

2. Collaborations with large number of authors

Appeared first in elementary particle physics

First example UA1 (Nobel for C.Rubbia , discovery of W, Z)

later LEP experiments (several hindered authors)

Now extreme in LHC experiments:

publications carry about 3000 names

extremest example: Higgs discovery: method and results 7 pages , author list 27 pages with 5154 authors

but now also in other fields:

astrophysics, astronomy, gravitational waves, even in theory and biology,...

How to give credit to individual scientists?

Divide publication by number of authors?? (HEPP 2015 'Ranking')

In 1983 (approval of LEP experiments) my proposals:

- a) a few publications explaining the concept of the experiment and its design signed by all authors, whereas later publications with specific results or technical topics signed only by those who contributed to the particular work.**
- b) the alphabetical order should be changed if all authors sign**

Both proposals are rejected until today for complicated social reasons

Present practice impractical in case of questions.

(recently in some LHC publications a contact person is given).

Consequences of many authors become serious

❖ **Jobs and promotions for individual scientists:**

Explain individual contributions to colleagues

(faculties, National Societies) is difficult but possible

Explain this to a committee including other sciences

almost impossible

Recent Example: Appointment of Sahal Yacoob

(University of Kwa Zulu-Natal). In South Africa

Department of Higher Education decided that publications with more than 100 authors are not recognised

(no employment or salary, but asked to lecture on Higgs.

Only settled by court trial)

(See Physics World 10 October 2015, pg15)

❖ Prizes

Example

DFG Leibniz Prize (each year 10 prizes, each EUR 2.5 million)

Committee members from mathematics to philosophy

No prize for physics in 2016 and 2017 (no good candidates ??)

Nobel Prizes

Maximum number of three scientists in one year.

large collaborations are excluded

The rule favors theoretical work done by individuals or small groups.

(Discovery of Higgs, Gluon, LEP results, etc)

Even for theoretical physics one can argue that in many cases the success is due to the contributions of many scientists

(see Schweber S.S., (2015), European Physical Journ.,40, 53)

❖ **Laboratories, centres of excellence:**

Funding agencies become more bureaucratic

Hesitant to take decisions

Example: Evaluation committee of EU Programmes degraded recently LIP in Portugal

(Laboratory for Instrumentation and Particle physics)

**all publications with many authors are not taken into account
(Higgs discovery has no value!)**

Also in the UK some committees ignore publications with more than 1000 authors

Germany: 'Centres of Excellence' depend on few scientists

What to do with many authors?

In spite of increasing awareness the situation is not improving.

No patent solution

- Continue to sensitize faculties, universities, prize committees, funding agencies etc
- **Ask Physical Societies and Academies to get active:**
 - DPG (article in Physics Journal March 2016)
 - EPS Council and Executive Committee, [HEPP Board](#)
 - Swiss Phys. Soc., Italian PS,
- **Collaborations should establish ways to make individual contributions visible to outside.**

Proposals by HEPP Board, but no follow up for **internal** recognition (chair of collaboration boards, committees, etc)

Hans Peter Beck, Communications de la SSP No. 49 and citations there

3.Evaluation of large projects

Another serious problem

What is the **social, economic or cultural value** of a scientific project?

Funding agencies ask progressively more often for economic **Cost/Benefit analysis** before approving large projects

European Commission is asking for a C/B analysis of projects costing more than 50 M EUR.

Also World Bank and European Investment Bank follow

Scientometric methods were developed by economists to evaluate commercial or industrial projects where cost and benefits can clearly be expressed in terms of cash using sophisticated mathematical methods (Lagrangian optimization method, canonical variables, probability distributions of etc).

Recently such methods were developed for research infrastructures at the request of EU and applied as case study to LHC at CERN since it is the largest infrastructure for basic research

(Pinski and Narin 1976, Martin 1996). Carrazza, Ferrara and Salini (2014), Florio et al (2015)

One has to learn language and mentality of economists:

The **value of scientific knowledge**
is proxied through its **opportunity cost**,
i.e. the value of time devoted to produce the output
(**marginal production cost concept**).

Price tag put on everything!

C/B analysis - Case study LHC

M.Florio et al (2015), University of Milano

A project is socio-economic valuable

if one single index

$PNV > 0$

Positive Net Value $PNV = \text{Benefits} - \text{Cost}$

Benefits : S Scientific knowledge

T Technology transfer

H Human capital formation

C Cultural benefits

E Existence value

Q Quasi-option value

Cost: C Capital cost

LS Labour Scientists

LO Labour other staff

O Operating cost

Benefits and costs discounted to a fixed time

Scientific Knowledge Value =

economic value of scientific papers = production costs,
which is the cost of scientific personnel, employed at the LHC and its
experiments,
proxied by their average hourly salaries)

+ **the value of citations** = **the time for reading and understanding
papers,**
(on average one hour needed to read and cite a paper) x average
hourly salaries

Human capital

Formation at LHC: over period 1993-2025 are 37000 young researchers (19400 students and 17000 post-docs). The LHC benefit is valued as the LHC-related incremental salary earned over the entire work career

Cultural Value

Benefits of LHC to the **general public visiting CERN**.

Calculated like Museum Value = number of visitors x entrance fee

For CERN entrance fee replaced by average travelcost

+ **benefit through social media** (time spent per capita GDP)

Existence value

In *environmental CBA* it is the benefit of **preserving** something known to exist; here the benefit of **knowing** that something exists.

Proxied by **willingness to pay**, ask population by enquiry

Q Quasi-option value

future but unpredictable economic benefit of science,
includes serendipity effects,

it is intrinsically uncertain and therefore not measurable,

Assumption $Q > 0$, set $Q = 0$

But this is one of the most important results of science!!

Benefits of LHC

in 10^9 Euro

Scientific knowledge	0.28 (negligible)
Technological spill over	5.4
Human capital formation (education)	5.5
Cultural benefits (Visitors, PR)	2.1
Existence value	3.2
Total benefits	16.4
Total cost	13.5
Net Social Value	2.9 decisive indicator!!

The gain of Scientific Knowledge is completely negligible !!

Probability spread of NSV comparable to ist value!

This indicates that the C/BA method cannot really evaluate the benefit of new scientific infrastructure in a quantitative way.

Differential results (e.g. Technology Transfer, Human Capital formation) are useful

Main danger:

Decision takers will not read the whole evaluation but take the Social Net Value as only criterium

For general criticism of method see

H.Schopper, Cost/benefit analysis for research infrastructures and their problems, Published in Technological Forecasting & Social Change, Elsevier, 2015 and

Overall Conclusions

There is a **growing tendency to evaluate scientific activities** which take a large part of public expenditure **more 'objectively', with more 'transparency'.**

With preferably just **one single index** (qualifying indicator)

Why?

decision makers are afraid to take the personal responsibility for complicated and expensive decisions

Academies could help by explaining to decision takers that a

decision always has to take into account

several criteria and in the end cannot be delegated to 'objective' indices but requires

personal resolve and responsibility.